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THE BEDSIDE MANNER IN RADIOLOGY[1]

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INTRODUCTION

IN discussing the bedside manner in radiology, I am impressed with a quotation from Hippocrates, "To serve the art of medicine as it should be served, one must love his fellowman." Byron Robinson said, "Adequate information concerning a disease can be obtained only at the bedside." Again, I quote from Alfred Stengel, "In the rapid development of the more rigidly scientific methods of diagnosis emanating from the laboratory, a feeling of disregard if not contempt for the other clinical methods has too often made its appearance, not rarely perhaps on account of a greater familiarity with many of the newer methods of investigation." A discussion of the bedside manner in radiology presupposes that the practice of radiology is accepted as the practice of medicine. It must follow then that radiology becomes a special branch or division of medicine.

Radiology, as a branch of medicine, has undergone the evolutionary processes pointed out so clearly by Thomas A. Groover and is now becoming stabilized as a specialty in medicine. The integration of radiological practice into the general practice of medicine as it exists in the United States to-day becomes a problem of prime importance. The scientific phases of radiology are already deeply rooted in the science of medicine, and it becomes our duty to organize ourselves for the proper application of radiology in the future. We must develop a strong and dignified group, carefully, but not overorganized, in order that radiology as a specialty may be equally attractive among the branches of medicine.

The preservation of a specialty in its proper form may become a more difficult undertaking than its creation. It seems quite evident that our scientific organizations, local, national, and international, with their essential purposes concerned with the presentation and dissemination of scientific data, have performed their duty most commendably. Problems arising in the practice of radiology may seem to have lagged, but this is only a matter of sequence in evolution. Through the American College of Radiology and its Commissions, many important movements have been initiated and activities are now in progress which promise much for future practice in this specialty.

PRACTICE

The practice of radiology, like other divisions of medicine, is deeply concerned with diagnosis as well as treatment. The diagnostic phase of radiology is indeed very broad and comprehensive. Diagnosis is not merely pinning a label on a disease, nor

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the determination of the structure involved. For example, through radiological diagnosis more information concerning the anatomical involvement in a case of pneumonia can be ascertained than by any or possibly all other methods combined. The radiologist must not forget, however, that as physicians our chief interest is not with deranged structure, but in the disturbance of function. In the case of acute lobar pneumonia and in many other important diseases, it is not enough to determine the amount of structure involved; one must, in addition, know the type of organism, if the blood stream has been invaded, or if the anatomical involvement is an incident to a pre-existing chronic ailment, and, if so, its character, leading complications, etc. Metaphorically speaking, the dead hand of Virchow still rests on the profession. We are so prone to designate the disease and cease further diagnostic investigation. The patient as a human being must be considered. He possesses a soul or a spirit or whatever you wish to call it. An example of medical neglect is Christian Science. Physical cultists and dietetic pseudo-experts reflect other aspects of medical indifference. It has been said that a physician caring for a patient and neglecting the emotional life is as unscientific as the investigator who neglects to control all conditions affecting his experiment. By this I do not infer that serious consideration of the disease and its treatment are not required, as is so obvious in diseases such as pneumonia, cancer, etc., but when the corner is turned and the immediate crisis over, then you must give your deepest attention to the patient.

It appears that we could do nothing more useful at this time, for the future of radiology as a division in the practice of medicine, than to stress the attitude toward the patient of those engaged in this specialty. We should urge that such consideration begin during the courses in undergraduate medical education.

Radiology, like all other divisions of medicine, has two general divisions among those engaged, the research workers and those in practice. In the beginning, research was most essential, but at present it becomes imperative that the practice of radiology be carefully analyzed and directed.

Whenever the problems concerned with the practice of any division of medicine are considered, there emerge for discussion two common factors, the patient and the doctor. For this, it is indeed but little different whether it be in connection with the practice of radiology, general practice of medicine, specialism, contract practice, state medicine, cost of medical care, health insurance, hospitalization plans, or whatnot. It is only natural that, if we accept our place as a group, practising a specialty in medicine, we must be guided by the principles of practice governing the other divisions.

To define just what shall be included in the practice of radiology and the exact status of the relation between the radiologist and the patient involves some very delicate, yet important, considerations. It is unfortunate perhaps that this differentiation must be created at a time when medicine is in so perilous a state of storm and stress. This uncertainty is not confined, however, to medicine. While looking about us we see that thrones are toppling, constitutions are being modified or scrapped, economic conditions becoming more unsettled, industrial and special groups are hostile, nations are angry and brandishing dangerous weapons; in fact, the whole structure of our civil organization seems to be threatened and the tranquility and stability of the future uncertain. It would be rash indeed to venture to predict what may be the status of medicine, or the relation between the patient and physician a century from now, or even a decade hence.

As our specialty becomes more stabilized, we see roughly two divisions in practice: one in which the radiologist's entire time is devoted to patients in group practice and his clientele referred; the other in which a portion or all of the radiologist's clientele is private and he directs the entire

medical management. With the private patient, the radiologist is obviously conscious that he is the patient's doctor. The radiologist with the referred clientele is, by the nature of things, in a somewhat different position and may become inclined to drift in the direction of the true scientist, who may discover a disease and direct its healing. May I urge that, without regard to the class of practice we undertake in radiology, we do not become disease detectors and curers, but above everything we remain physicians in our attitude toward the patient. In this connection something can also be said with regard to the attitude of the patient. It is obvious that already the public conception of the radiologist is not indicated in the question, "What disease have I and will you cure it?" but rather it is indicated in the question, "Doctor, will you endeavor to determine why I am not well, and assist me in restoring and keeping my health?"

The principles of medical ethics, observed by the radiologist, should correspond to those in other divisions of the practice of medicine. If the radiologist is in private practice, the major portion of his work will be in his management of the clientele, referring such cases as become necessary to other specialties, and correlating all of the required data for proper care. If the radiologist has a consulting practice in connection with the medical staff of hospitals, clinics, and other institutions, his study of the patients and his relationship with them varies considerably, inasmuch as it is more indirect—through the referring physician.

For the benefit of the future of this specialty, there should be a strong group within it who practise the bedside manner in radiology. There is a public demand for this character of medical service. It would not interfere with the radiologist in group practice. Considering these two types of radiological practice, there arises again the question of the individual relation between the patient and the physician. It seems almost certain that the radiologist in group practice must sacrifice individualism, but he should preserve his personality with the patient.

The reaction of patients who have received radiological service in different medical groups convinces me that the radiologist performs a greater service to the public and to the profession when he maintains a proper personal relationship with the patient. It seems wholesome, indeed, when patients speak the name of the radiologist who was connected with the clinic or institution where they received medical service. They frequently express appreciation and praise for courteous and kindly service, while in connection with other institutions of equal professional standing they do not hesitate to state that they never met the radiologist in charge and that their service through the technicians became more one of machine-shop variety. Only recently I became quite interested in the description by a patient who seemed anxious to relate her experiences in a radiological department of a large medical institution. She described her approach to the department, which was appropriately decorated, the general atmosphere quite acceptable in spite of the great amount of equipment which appeared well kept and in good order, and one of the many examining rooms which might ordinarily be depressing became pleasant because the technical worker appeared so friendly while preparing the equipment for the examination, and a few moments later this same technician introduced the radiologist who was head of the department. He inquired briefly but sufficiently into the cardinal symptoms, correlating them with the order from the floor, which indicated the information desired by her doctor, and then very quickly gave the proper orders to the technical workers for the examination. The patient was fully convinced that all of the work of the department was being directed by a physician and expressed gratitude for her doctor's recommendations.

If we feel degraded by being designated as "the x-ray men" for the hospital, the clinic, or the group, we must not approach

the patient with an order from the doctor to "ray the elbow for me" or "give him a couple of shots of Coolidge on the eczema about a week apart." The public conception of radiology in the practice of medicine is indeed very largely determined by the personal attitude of the radiologist in his relations with the individuals when they receive medical service from those engaged in this specialty.

The radiologist who undertakes the bedside manner of practice, becomes the patient's doctor and assumes the obligations of the medical management, must study and develop the bedside manner of a physician. This requires mutual understanding and confidence between the patient and the radiologist. This confidence is a subtle thing and requires, on the part of the patient, complete truthfulness in disclosing all relevant facts, and, on the part of the doctor, absolute sincerity and as much truthfulness as is compatible with his other responsibilities. In the interest of the patient he cannot always be completely frank. Private communications may sometimes forbid, but his opinion and conclusions must be discussed frankly and truthfully with the patient or some immediate friend.

At the bedside we must not disclose hesitation or doubt. Remember, the patient studies the doctor's frame of mind and often watches anxiously for changes in his expression, voice, etc. On the other hand, a radiologist should not beguile his patients, nor attempt to inspire their confidence by becoming an actor, for most patients are quite able to tell when self-confidence merges into self-conceit, and there are examples when it appears to become a megalomania.

EDUCATION

The bedside manner in the practice of radiology enhances the value of medical radiology to the patient and it also creates the opportunity for its individual teaching in medical education. It is true that the policy of group formation in medical practice is being urged upon the medical profession at this time. Obviously, as these groups multiply there will come to be group selection by the patients and ultimately this leads to mass treatment. It is singular to note that, as this policy is being pressed upon us, analogous fields are rejecting it. For example, until recently crime and insanity were treated almost exclusively by mass confinement in asylums and prisons. Mass educational work was glorified. For the relief of poverty, alms were dispensed to large groups in poorhouses, etc. It seems that in all of these lines progress has been measured very largely by the extent to which individual personal relationships have supplanted mass measures. Medical education is no exception. Formerly large groups of medical students came day after day to the amphitheater for didactic lectures and operative demonstrations, but now we find small groups in close contact with the instructor in clerkships, ward walks, and in actual bedside teaching. I would like to emphasize to those who are now teachers in under-graduate, as well as graduate, medical education, the importance of pointing out to their classes the great advantages of individual and bedside teaching in radiology. We must remember that before long the older generation of teachers will be replaced by the younger men, and it is our duty to see that they possess the proper viewpoint.

The teaching of radiology involves something concerning the bill for services. The work of the professional men in the administration or medical service is often inappropriately measured in dollars and cents. In group practice the fees may seem more uniform and the relations between the radiologist and the patient, being more indirect, may ameliorate somewhat the difficulties concerned with financial settlements. I do not mean that the collection of compensation for radiological services is not an obstacle to be surmounted by those in group practice. It is, however, obvious that after a close relationship has been established between a physician and a patient, there is indeed no delight in re-

questing payment for your services. This situation is aptly depicted in the old cartoon in which the doctor appears in three aspects: First, as a blessed angel when he calls at the bedside of the sick patient; second, as a veritable god when the cure has been perfected and the patient returns to his feet, and third, as the very devil when he presents his bill. Whatever we may draw from this, it becomes evident that the patient's reactions are occasionally somewhat violent in character and demonstrate the emotional rather than the rational responses.

COMMENTS

In these times when our living conditions are changing so rapidly, and when one scientific achievement follows so closely upon another, radical moves along all lines are more likely to occur. Human relationships are being examined in all of their phases and many are in a state of readjustment at this moment. Before us are problems, individual and collective in character, which threaten to change the general order of almost every pursuit in life; the education of the medical student and the practice of medicine offer no exceptions. It becomes our duty in this organization of teachers of radiology to avoid, so far as it is humanly possible, the sowing of the seed of over-socialization or the creation of state medicine.

In closing, let me reiterate that the essential quality of a physician is interest in humanity. In the bedside manner for radiological practice, time, sympathy, and understanding must be lavishly dispensed. The reward will be found in that personal bond which forms the greatest satisfaction to the physician in the practice of medicine. Responsibility should be something tangible. It seems best if it be individual, but for the radiologist in group practice, I admonish you to preserve your personality. The most ideal relationship between patient and physician is one of mutual trust. Where there is a deep spirit of trust, there follows no suspicion nor misunderstanding. When these conditions prevail, the period of illness becomes, as it were, a return to childhood's dependency. The patient experiences a freedom from responsibility, a resignation to the care of his physician, the nurse, and the hospital, and recovery is thereby speeded, if it is at all possible.

INTEGRATION OF CLINICAL AND ROENTGENOLOGIC FINDINGS IN THE DIAGNOSIS OF CARCINOMA OF THE ESOPHAGUS

A STUDY OF 100 CASES[1]

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THERE are few locations in which cancer is attended by such a hopeless prognosis as in the esophagus. Except in isolated cases, methods of treatment successfully employed in other organs are unavailing here. Irradiation, whether administered as radium or x-ray, has not been successful. At present, surgery probably offers the best method for coping with the condition. Surgical procedures in carcinoma of the esophagus are accompanied by high mortality, because usually when the patient is first seen the condition is so far advanced as to make surgery impossible.

This study was undertaken in an attempt to determine if correlation of the clinical and roentgenologic findings might reveal signs by which carcinoma of the esophagus could be diagnosed earlier and at a time when it would be amenable to surgery.

One hundred cases were selected; in 78 the histologic diagnosis was squamous-cell carcinoma, in 18 adenocarcinoma, and in four undifferentiated carcinoma. Thirteen of the tumors occurred in the upper third of the esophagus, 39 in the middle third, 39 in the lower third, and in nine the location was not determined. The clinical and roentgenologic data were analyzed as to sex, age, family history, serology, symptomatology, and the roentgenologic findings.

Sex and Age.—Ninety-three patients were males; seven were females (Table I).

Ages ranged from 20 to 80 years. There was one patient, a male, 20 years of age; 71 were between 50 and 70 years, and made up the largest group; of these, 34 were between 50 and 59 years, and 37 between 60 and 69. The number in these sixth and seventh decade groups is higher than the percentage of cancer in other localities.

Family History.—Only eight patients came from families in which some relative had suffered from cancer; 91 patients gave no history of malignancy, and in one history there was no record. In only one instance was there more than one cancer recorded in the family history: a male, 64 years of age, had two sisters who died of cancer. In none of the family histories was there a record of cancer of the esophagus.

TABLE I.—CARCINOMA OF ESOPHAGUS

	Sex and Age		
	93	7	
Years	Males	Females	Total
20–29	1		1
30–39	1		1
40–49	11	1	12
50–59	33	1	34
60–69	33	4	37
70–79	14	1	15

Serology.—The reaction of the blood to the Wassermann or Kahn tests was recorded in 69 cases; in 31 it was not stated. There were 64 patients whose blood was negative and five with positive reactions.

Symptoms.—Symptoms have been analyzed as to incidence, initial symptom, and duration of the initial symptom before diagnosis was made (Tables II and III).

Dysphagia was the most constant symptom and had the highest incidence as an initial symptom; 96 patients complained of it and 71 listed it as the first. Dysphagia was usually of gradual onset, difficulty being first experienced with solid food, and finally, as the disease progressed, difficulty with fluids also developed. Sometimes it was of sudden onset. Of the 71 patients in whom it was the first symptom, 38 (or

[1] Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13–17, 1937.

TABLE II.—CARCINOMA OF ESOPHAGUS

	Symptoms Incidence	As Initial Symptom
Dysphagia	96	71
Pain	73	11
Loss of weight	81	2
Loss of strength	13	
Regurgitation	65	3
Belching	11	1
Indigestion	7	7
Vomiting	6	1
Hematemesis	3	
Hoarseness	6	2
Cough	1	1
Swelling of neck	1	1

TABLE III.—CARCINOMA OF ESOPHAGUS

Duration of Symptoms			
Less than one month	2		
1–2 Months	11	58	Less than six months
2–3 "	18		
3–4 "	11		
4–5 "	11		
5–6 "	5		
6–7 "	13		
7–8 "	6	29	Six months to one year
8–9 "	2		
9–10 "	5		
10–11 "	2		
11–12 "	1		
12–18 "	8	12	More than one year
18 Plus	4		
Unknown	1		

53.5 per cent) had difficulty in swallowing for less than six months before coming under observation, and 23 (or 30.9 per cent) had it only from six months to a year. In only two patients was the dysphagia present for more than 18 months.

Pain was the second most frequently encountered symptom of onset. Of the 73 cases in which it occurred, it was the first symptom in 11. In six histories it was recorded that there was no pain. It was variously described as soreness, distress, or intense pain. The most common site was the midline of the thorax, though in some patients it was located in the epigastrium: sometimes it radiated to the back. In most patients it came on after eating, though in some it was constant and bore no relation to the taking of food. As the symptom of onset it was present for less than six months in seven instances and from six months to a year in two cases.

Loss of weight was present in 81 cases, absent in five, and was not mentioned in 14 histories. Two patients listed it as the first symptom: in one, a male, 62 years of age, the loss had been gradual and amounted to 20 pounds (9 kg.) in eight months; the only other symptom of which he complained was dysphagia. The second patient was a male, 60 years of age: he complained also of dysphagia, belching, and regurgitation. In 49 patients the amount lost was recorded; it averaged 25.7 pounds (11.6 kg.) per patient. The greatest loss took place in a male, 46 years of age; he lost 130 pounds (59 kg.) in 11 months. In 13 patients weakness accompanied the loss of weight.

Regurgitation was complained of by 65 patients, 12 patients had none, and in 23 histories it was not mentioned. It occurred three times as the primary symptom; in one patient it had been present for three months, in two patients for four months. In 25 patients who complained of regurgitation the lesion was in the lower third, in 21 in the middle third, and in nine in the upper third.

Belching was recorded in 11 instances; in one patient it was the first symptom and had been present from seven to eight months before the patient came under observation. The growths in these patients were in the lower third in five cases, in the middle third in two, in the upper third in two, and in two the location was not determined.

"Indigestion" was the chief complaint of seven patients, in all of whom it was the symptom of onset. The term really indicated a number of symptoms referable to the gastro-intestinal tract, no one of which was so marked as to deserve particular comment at the time of onset. These patients complained of general malaise, frequently with heartburn, belching, or regurgitation. Dysphagia was not a marked symptom. Patients who gave indigestion as the initial symptom also had the longest interval between onset of the symptom and final diagnosis: one patient had recurring attacks of indigestion for many years. Two patients in whom the first symptom was dysphagia of more than

18 months' duration gave antecedent histories of indigestion.

Vomiting was recorded in six histories: one patient in whom it had been present for two months before the diagnosis was made, gave it as the symptom of onset. At necropsy the cancer was at the lower end of the esophagus and extended into the stomach. The tumor in four of these patients was in the middle third and in two in the lower third.

Hematemesis occurred in three cases, though not as the initial symptom; but in one patient, a male, 73 years of age, with a fungating growth at the lower end of the esophagus, the symptom of onset was sudden severe pain in the abdomen followed by gastric hemorrhage. In the other patients the tumors were in the middle third.

Hoarseness was complained of by six patients: in two, it was the symptom of onset, in one patient had been present for less than two months, and in another for less than three. In this second patient there was an associated paralysis of the left vocal cord. In two patients the lesion was located high in the esophagus, in two it was in the middle third, and in two in the lower.

Cough was the symptom of onset in one case. It occurred with pain in the throat on swallowing in a male, 57 years of age, who had a squamous-cell carcinoma of the middle third with obstruction high in the esophagus. There were no other instances of cough as a symptom.

Swelling of the neck as the initial symptom was complained of by one patient, the only case in which it occurred. The patient was a female, 55 years of age, who had the swelling for six months. She had a squamous-cell carcinoma involving the middle third and extending upward almost to the pharynx.

Duration of Symptoms.—In 87 patients the interval from the first symptom to the time the diagnosis was made was less than a year: it was less than six months in 58, and between six months and a year in 29. In only 13 was it present for more than a year.

Roentgenologic Characteristics.—The roentgenologic characteristics of far advanced carcinoma of the esophagus are generally known and no attempt has been made to tabulate the findings. The alterations of contour in the opaque stream used to examine the esophagus correspond to the alterations in the lumen of the organ produced by the tumor. These alterations are usually irregular, and involve one or more sides of the tube when the growth extends in a cephalo-caudal direction, or constrict its entire circumference when it is annular. The irregularities of contour are always associated with narrowing of the lumen at the site of the tumor, and usually, with dilatation of the esophagus proximal to it. Sometimes the constriction is smooth and difficult to differentiate from stricture due to the swallowing of a caustic; when smooth and at the hiatus, differentiation from functional spasm may be impossible.

There was positive roentgenologic evidence of organic disease thought to be due to neoplasm in 95 patients, indicating that in this series, as in most, the disease was far advanced when the patients first presented themselves for examination. In the others there was found evidence of alteration, but the diagnosis was not properly made as to the etiology. One patient with cancer was diagnosed as having a caustic stricture, another as having a phrenospasm.

The opposite error is sometimes made: that is, some other lesion is mistaken for carcinoma. These mistakes are not so disastrous. The most common errors are made in mistaking caustic strictures and phrenospasm for neoplasms, and occasionally diverticula and varices are improperly labled newgrowth. In some instances constriction of the lumen by extra-esophageal masses may lead to an appearance simulating an intrinsic growth.

Phases of the roentgenology of carcinoma of the esophagus worthy of special comment are: the difficulty in determining in cases at the hiatus whether the tumor is

primary in the esophagus or involves it secondarily by extension from the stomach; the relation of foreign body lodgment to the condition; the pulmonary and pleural complications due to fistulæ with the formation of abscess or empyema; the development of suppurative foci in the lungs without fistula formation; pulmonary and vertebral metastasis.

While often the determination as to whether the carcinoma arose in the esophagus or was involved secondarily by extension from the stomach is academic, in some instances it is important to determine if there is gastric involvement. This is particularly true when the question of resection of the esophagus or stomach arises. When the stomach and esophagus are involved in the same growth the tumor is usually located along the anterior and lesser curvature sides of the stomach.

In occasional instances, the lodgment of a bolus of food at the site of the growth, with sudden and complete obstruction of the esophagus, may be the first sign of neoplasm. It is important, therefore, that the esophagus be re-examined after the removal of the lodged bolus, to exclude the possibility of malignancy.

Sometimes a fistula develops between the esophagus and a bronchus, due to erosion of the esophagus by the growth, or a sinus may develop between the esophagus and the pleural cavity. When a fistula forms between the esophagus and the air passages a pulmonary abscess may develop. Abscesses of this type present the usual roentgen characteristics with cavity and fluid level. Empyema secondary to invasion of the pleura by the growth is usually complicated by the development of a pyopneumothorax from the air which gains entrance to the pleural cavity during the act of swallowing.

When the tumor develops in the upper third of the structure it may cause a spill-over of material into the larynx and trachea. In these cases there may develop multiple suppurative pulmonary foci instead of a single abscess. The foci are more commonly seen in the dependent portion of the lungs, in the lower lobes.

Metastasis to the lungs presents the same appearance that metastasis from other tumors shows. When metastasis occurs in the vertebræ, it is usually of the osteoclastic type attended by varying degrees of destruction of the involved vertebræ.

COMMENT

Analysis of the clinical and roentgenologic findings does little to bring about the end for which the study was undertaken, namely, the unearthing of signs and symptoms by which diagnosis of cancer of the esophagus can be made earlier. However, certain facts have been emphasized and are worthy of note.

Cancer of the esophagus occurs three times more frequently in the lower third and in the middle third than it does in the upper. It is twelve times more frequent in male than in female patients. Age at the time of onset is higher than in cancer in some locations, 86 per cent of the patients being over 50 years of age.

Familial malignancy seems to play no rôle: in 91 per cent there was no history of malignancy, and cancer of the esophagus was not recorded in a single instance. While it appears that heredity plays a negligible part, it should be borne in mind that the records were only those of the immediate family, the collateral lines not being included.

The influence of syphilis is of no apparent import, for in cases in which the blood was studied the ratio of the negative to positive reactions was as 13 to 1.

If any progress is to be made in early diagnosis, it will have to come by making patients conscious of the importance of early symptoms. In this series of cases, as in most series, the majority of the patients must have been suffering from advanced malignancy at the time they first came under observation, for the symptoms were of relatively short duration. Symptoms were present less than six months in

58 per cent and less than a year in 87 per cent. This short duration indicates that esophageal tumors are rapid growing.

As would be expected, mechanical interference with swallowing leads to dysphagia, the most frequently encountered initial symptom and the one with the highest incidence. The rapidity of its development and the pain which commonly accompanies it are the only features making it at all unlike dysphagia in other conditions. Seventy-three patients complained of pain of some degree during or after swallowing. Pain is not an accompaniment of dysphagia in phrenospasm, diverticulosis, or esophageal varices.

Other symptoms sometimes associated with obstruction of the esophagus make it important that the esophagus be studied when they occur. Regurgitation and vomiting belong in this category. Regurgitation has no apparent relationship to the site of the tumor, the percentages of the sites, and the percentages of the sites in relation to regurgitation being practically the same when the cancer was in the middle and lower thirds, and lower only when it occurred in the upper. Vomiting occurred only with growths in the lower and middle thirds.

While hoarseness, hematemesis, and cough are not common symptoms in carcinoma of the esophagus, the possibility that esophageal malignancy may be responsible for them should be borne in mind, and esophageal cancer excluded when there is nothing else to account for these symptoms.

Patients with carcinoma of the esophagus do not seem to come under roentgen observation until the disease is far advanced, for in 95 per cent the diagnosis of organic disease was made and malignancy suspected at the time of the first roentgen study. If roentgen signs leading to early diagnosis permitting of radical surgical procedures are to be discovered, patients will have to come under observation earlier in the course of the disease than they do at present.

SOME IMPORTANT CONSIDERATIONS IN THE ROENTGENOGRAPHIC DEMONSTRATION OF TISSUES, NORMAL AND PATHOLOGICAL, HAVING A RELATIVELY LOW DIFFERENTIAL ABSORPTION[1]

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THE radiographic demonstration of tissues having low differential absorption presents certain difficulties which should be thoroughly understood if consistent results are to be expected. Successful soft tissue radiography aims to demonstrate these structures with the same detail as that obtained with the conventional radiograph of the osseous structure. Mere outlines do not constitute an adequate examination.

A consideration of the soft parts will soon convince one of the great complexity of the structures and the slight differential absorption of contiguous structures. We may consider these tissues as consisting roughly of concentric layers of tissue, the outer ones being completely circumferential, enclosing in turn smaller layers consisting of bundles of muscles, vessels, and nerves. Between these layers and within there are innumerable potential fascial spaces, sometimes containing a small amount of fat. It is these spaces which give the necessary variation in density, be it ever so slight, to record the detail on the radiograph. They extend between the muscle bundles of a single muscle as well as enclosing vessels and nerves. They are distensible by air, having a remarkable intercommunication.

Briefly stated, the problem becomes one of obtaining the maximum contrast throughout the entire scale of density and consistently duplicating results. Up to a certain point the gradation scale contrast is dependent on the wave length, other factors remaining the same. Thus, best results are obtained with "soft" or low voltage radiation, provided adequate penetration of the part being studied is secured. Under-penetration obliterates detail even more completely than over-penetration. As is the case with conventional osseous radiography, there is an optimum kilovoltage where the best results are obtained. There is a common feeling that a "soft" effect can be obtained by merely underdeveloping. Correct exposure and development are essential. If one changes the effective beam by increasing the voltage or increasing filtration, or both, the "snap" or "sparkle" of the radiograph is gradually lost and the differential detail tends to flatten out. In a series of comparative tests we were able to show that full wave rectification gave superior results as compared with half wave on the same part. The character of the beam of radiation obtained by various types of radiographic machines is dependent on various factors, most of which are well understood.

The factor played by the milliampere-second ratio is definite but less understandable. It has been our experience that under most conditions 300 ma.-sec. is the optimum. An exception may be noted in the case of some small self-rectified portable units by means of which soft tissue radiography of small parts may be satisfactorily made with a smaller ratio.

The element of motion does not play so important a rôle in extremity work as elsewhere. The limb can be immobilized by sand bags and the movements caused by pulsation of arteries do not seem to cause trouble.

In cases in which there is such a small permissible variation in technic it becomes obvious that all sources of current fluctuation must be eliminated and that regulation of the machine must be fine and accurate. Thus the supply line should be of ample size. Autotransformer control is far superior and should have steps of not less

[1] Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13–17, 1937.

No. 1. Soft tissue radiograph of muscles of the calf, showing a moderate degree of atrophy. This is indicated by the increase in width and decrease in density of the intervesicular spaces in the muscles. This gives rise to a rather marked striated appearance. Sometimes this is noted before there is an actual demonstrable decrease in size of the muscle.

No. 2. A racemose, non-encapsulated hemangioma of the soft tissues over the right shin. Note the worm-like vascular structures. This is characteristic of hemangioma.

No. 3. Radiograph of normal brachial vessels. Soft tissue radiography is ideal for demonstrating early calcific changes, particularly in the small arteries.

than 2.5 kv.p.: larger steps will result in too marked variation, especially when dealing with the smaller parts. The current source should preferably not come from a transformer which has a heavy fluctuating demand from some other source.

The x-ray tube requirements for soft tissue radiography are in general similar to those of other types of work, *viz.*, as small a focal spot as is consistent with the permissible energy load of the tube. In this connection it should be remembered that inasmuch as the kilovoltage is low a larger milliampere-second ratio can be tolerated without exceeding the energy limits. The target should be in the best condition, as a pitted target tends to reduce detail. While probably better results can be obtained without the use of a filter, the small amount of filtration inherent in the oil of a shock-proof apparatus is negligible from a practical standpoint. In the range of lower than 30 kilovolts the absorption of the radiation by the glass wall of the tube probably plays a significant part.

The X-ray Film.—The ideal characteristics of emulsion for soft tissue work are as follows:

(1) There should be considerable latitude to compensate for variations in exposure caused by miscalculations or fluctuations of the line.

(2) *Maximum contrast:* There should be a maximum differential between the blackest blacks and the whitest whites.

(3) *A long gradation scale:* That is, the maximum contrast should hold throughout the entire gradation scale. We have coined the word "diatrast" for this attribute.

(4) *The speed of emulsion:* While an increase in speed of the emulsion is desirable, nevertheless it is not of major importance.

(5) *Keeping qualities, particularly freedom from inherent fog:* This is a matter of

considerable importance as the presence of fog is exceedingly detrimental to the fine detail in soft tissue radiography.

(6) *Uniformity:* This is a matter of great importance as it permits the standardization of a rather exacting technic.

Intensifying screens are used, single screens preferably, but a double screen gives excellent results. Screen speed should not be too fast as graininess may result, which has some effect on the detail. Needless to say, the screens should be kept clean and the cassettes should always be in good contact. The intensifying screen should not be kept too long, as age apparently has an effect on the resulting radiograph.

Development is very important and is done by "sight." A routine time-and-temperature development is not suited to this work. The film is inspected during development as infrequently as possible, and when the part it is desired to demonstrate becomes visible, the film is removed from the developer. As we remarked earlier, there is an optimum exposure which is critical as compared with conventional radiography and which can be corrected only to a small extent during development. Too dim a safe light makes visible developing difficult. The solutions must be fresh and at the proper temperature. Fog from any cause must be avoided. Pincryptol green may be used for desensitization in order that the films can be developed by weak white light without fogging. While this has the advantage of permitting more critical development, the results are hardly worth the extra procedure necessitated by desensitization. The film should be thoroughly washed, dried fairly rapidly in a dust-free, warm column of air.

The finished radiograph should be illuminated by lights of various wave lengths and intensity. It is surprising to see how certain soft tissue shadows can be made apparent by changing the intensity or quality of the illumination. No study of a soft tissue radiograph is complete without varying the illumination.

It is a matter of vital importance to have some medical member of the x-ray department responsible for all radiographic examinations involving soft tissues. If this is not the case, the technic is apt to fail, particularly at the start, as it requires constant supervision by some one having medical knowledge and interest in this work. At the New York Hospital the soft tissue radiographs are developed by "sight," usually by the technician who made the exposure, in a small separate dark room. If the development is attempted in the large main dark room, the routine work is apt to be held up or else the soft tissue radiographs rushed through without adequate attention. Carelessness or hurry is fatal to good results. The very fact that consistently good soft tissue radiography can be done in a large department is an indication in itself of good organization. After a period of time during which the technicians become familiar with the work, the supervision necessary may be considerably reduced and still the quality of work may be maintained.

THE IMMEDIATE AND END-RESULTS OF RADIATION THERAPY IN CERTAIN BENIGN BONE TUMORS[1]

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THE widespread application of radiation therapy in certain benign bone tumors, notably giant-cell tumors, has made it seem worthwhile to review the results of this type of therapy, and to compare them with the results of surgery. An increasing number of reported results are accumulating each year so that some estimate as to the relative value of radiation therapy in this field should be possible.

The traditional surgical treatment has been amputation, resection, or curettage, with or without cauterization. The results obtained by the use of these methods are well known.

The experience of various observers, particularly Bloodgood, has been such that the name *giant-cell sarcoma* has been replaced in this country by the name *benign giant-cell tumor*. In spite of this, there are an increasing number of so-called giant-cell variants being reported. Other cases are being reported in which malignancy supervened following some form of trauma. Some of these cases had undergone radiation therapy. A discussion of this aspect of the subject will be given. Several cases of malignant variation will be reported.

We will first consider the problem of the benign giant-cell tumor. This tumor is found in youth, and through the middle decades of life, but is more common in the third decade. It occurs most frequently in the distal ends of the diaphyses of the femur and radius, and the proximal end of the tibia. It may occur, however, in the diaphyseal ends of any of the long bones, the mandible, or flat bones. Many authors state that these tumors involve the epiphyses of the bones, but as Peirce (19) points out, this terminology is incorrect. It occurs in the metaphysis and does not cross the epiphyseal line until this cartilage line has disappeared and has become ossified. It may break through the capsule and invade the soft tissues, but rarely extends into the joint cavity.

On the roentgenogram, this tumor is revealed as a cyst-like osteolytic tumor in the ends of the diaphyses. It is often eccentrically placed, expanding and thinning the cortex on one side and extending medially at the expense of cancellous bone. When centrally placed, it expands the cortex equally on either side. The cortex has a thin bony outline which is frequently perforated, and which when intact, has every appearance of fragility. There is an absence of periosteal elevation or reaction such as is present in osteogenic sarcoma. Evidence of invasion is not seen. Bony trabeculæ are often present, producing a picture similar to that of a multilocular cyst. The radiographic signs are characteristic, and a definite diagnosis can usually be made by this examination alone.

The gross appearance of the tumor is that of a friable or jelly-like substance, which varies in color from red to gray or black. Bloody fluid is often found in these tumors, and excessive hemorrhage is one of the contra-indications to biopsy, according to some authors. The cortex is thin and is composed of new bone laid down by the periosteum as it is pushed outward by the growing tumor.

Histologically, the tumor shows large multinucleated giant cells, either scattered or in clumps. These cells contain multiple nuclei and may inclose blood cells, detritus, bone granules, or lipoid material. The supporting structure contains fine capillaries with both spindle cells and round cells. In the typical giant-cell tumor the

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round cells predominate. Hemorrhagic areas are often present throughout the tumor. Newly formed bone may be seen in the capsule, and occasionally parts of the old bone undergoing destruction.

Radiation therapy in giant-cell tumors of bone was popularized by the report by Herendeen (10) in 1924, of the results obtained in a series of 16 cases treated by irradiation only. At that time the dosage recommended was sufficient to produce a skin erythema and a considerable reaction in the tumor. This was manifested by rapid enlargement of the tumor with expansion of the cortex and thinning and decalcification of the bony shell until it was barely visible. The soft parts were swollen and edematous to the touch. This gave the appearance of rapid increase in growth of the tumor at this stage. After some weeks or months the swelling subsided, the tumor became firm to the touch, and the roentgenograms disclosed recalcification in the tumor outline.

In a later report Herendeen (11) reported a marked reduction in the radiation dosage. He stated that bone regeneration followed more promptly and complications were less common with lighter dosage. He stated that if light dosage does not give the desired result, the lesion is probably not a benign giant-cell tumor.

Among the many later reports on this subject are excellent contributions by Peirce (19, 20, 21), Lacharité (14), Evans and Leucutia (6), Pfahler and Parry (22). Soeur (26), and others. The general tendency in dosage has been downward until at the present time a destructive reaction is avoided. Most reports indicate a gradual reduction in the dosage in succeeding treatments.

Our practice has been to use 185 to 200 kv. with 0.5 mm. copper plus 1 mm. aluminum filtration at 50 cm. target-skin distance. Our dosage varies from 400 to 500 r units applied through each of two or more portals of entry. A full dose over each port is usually applied at one sitting. The progress is watched by means of periodical roentgenograms and clinical observations. Succeeding treatments are given at intervals of from two to three months, depending upon the clinical findings. With this treatment there is a minimum soft tissue and bone reaction, although decalcification can take place even when the dosage has been insufficient to produce a skin erythema.

The important factor in treatment is the determination of a correct diagnosis. If there is a suspicion of malignancy present, the dosage must be raised to the upper limit of tolerance of the skin and underlying structures. Indecision and caution in the face of malignancy can lead only to disaster.

Most authors strongly advise against the placing of radium in the cavity of these tumors as tending to militate against the production of new bone to obliterate the cavity. Radiation necrosis of bone is to be avoided in all cases.

In order to determine the effectiveness of radiotherapy in the treatment of this disease, we have analyzed the results reported by some of the writers on this subject. Herendeen (10), in his first report in 1924, gave his results on 16 cases. At that time he believed that all of those cases could look forward to complete cure, or restoration of function. In 1926, in a second report (11) on the same 16 cases, he stated that 14 of these cases continued to improve or were still free of symptoms. One of the others was a case of mistaken diagnosis and the extremity was amputated. One suffered a recurrence and after further radiotherapy was reported to be well. At the present time (13), these 14 cases continue well with no evidence of recurrence or activity of the growths.

Lacharité (14) reported his results in 14 cases, in 12 of which the tumors were in the mandible or maxilla. He claimed good results in all his cases.

In 1931, Simmons (25) analyzed the cases in the Bone Tumor Registry prior to 1925. Among these cases, amputation cured 100 per cent; resection was successful in 100 per cent of the cases in which it was used. Curettage cured 63 per cent.

Radiotherapy cured 75 per cent of the cases in which it alone was used. Coley's serum cleared up 42 per cent in a series of seven cases.

Pfahler and Parry (22), in a report of 26 cases, state that all obtained good results from radiotherapy. One of these cases was probably the first recorded case of giant-cell tumor treated by radiotherapy. These authors gave no detailed discussion of their cases.

In a recent report by Peirce and Lampe (21), a total of 83.2 per cent of their patients, treated by radiotherapy alone, obtained a satisfactory result, while in those cases in which it was used post-operatively a total of 85 per cent were well. In a small group who had both pre-operative and post-operative radiotherapy the result was satisfactory in only 40 per cent of the cases. Geschickter and Copeland (9), in their recent publication, report ten cases that have received radiotherapy: five had had satisfactory results, and in five surgery was used later. It is not stated who treated these cases or what radiotherapeutic technic was used.

We have recently made a study of 22 cases of benign giant-cell tumors from the Bone Tumor Registry, which had sections showing the histology of the original tumor and a satisfactory follow-up later. There were nine cases treated by radiation only, in which the patient remained well: four cases were well after receiving both curettage and radiation therapy, while in five cases radiation therapy was applied and resection or amputation was performed later. The patients are all well. One malignant variant was treated by amputation and the patient was well four years later. In three cases of benign giant-cell tumor which received radiation therapy the lesions later became malignant: one showed typical fibrosarcoma and two osteogenic sarcoma; one received roentgen therapy only, while two received curettage in addition to roentgen and radium therapy. In two other cases, which had only an original x-ray diagnosis of giant-cell tumor and no confirmatory sections, the lesions later showed definite evidence of malignant transformation. These two cases received roentgen therapy only; we do not include these as proved cases.

In only four of our cases of giant-cell tumor which were treated by means of radiotherapy do we have a satisfactory follow-up to determine the end-results and present condition. In one case the patient is free of the tumor but sustained a telescoping of the lower end of the femur, probably due to over-irradiation. In a second case the result is satisfactory. In a third case, to be presented here, malignancy developed during the course of treatment and amputation was done. The patient is well at this time although metastatic glands were found in the groin after amputation. In the fourth case, malignancy was present at the time of admission. X-ray therapy controlled this tumor for more than a year, but because of enlargement of the growth intra-abdominally, the patient decided to try serum therapy. Death occurred several months later.

MALIGNANT VARIATION

The argument as to whether giant-cell tumors ever undergo malignant transformation has been a long one. Nelaton is said to have been one of the earliest advocates of the opinion that they are always benign and never metastasize. Coley (3) quotes Virchow at length as believing that giant-cell tumors not only recur, but may prove to be malignant in some cases.

In 1930, Geschickter and Copeland (8) studied all the cases of the metastatic group of giant-cell tumors, from the literature and from the records of the surgical-pathological laboratory of the Johns Hopkins Hospital. They studied eight cases and came to two important conclusions: (1) Whenever metastases were found, they showed the histology of osteogenic sarcoma, and not of the original giant-cell tumor; (2) in no one case of an originally benign and typical giant-cell tumor have they found a secondary metastatic osteogenic sarcoma in the lung. In four of the cases, diagnostic errors were made, either

in ascribing deaths from other causes to metastases or failing to recognize the histology of the original lesion as sarcoma. In the remaining four cases, material from the original lesion was not saved for study so that the diagnosis could not be checked.

Stone and Ewing (27) reported a case of giant-cell tumor which, after curettage, had radium placed in the cavity. Eleven months later pain recurred in the leg and the lesion was again curetted and later amputated; death occurred eight months later from pulmonary metastases. They believe that radium should never be placed in the tumor cavity, but that external irradiation should be used in these cases. They state that a malignant growth developed out of a benign lesion as a result of various insults, in which curettage and imperfect irradiation played the leading parts. In Geschickter and Copeland's (8) study, described above, they believe this case was a case of "osteogenic sarcoma of the chondroblastic type, which frequently shows a resorptive giant-cell phase."

In 1931, Simmons (25) analyzed the cases of giant-cell tumors in the Bone Tumor Registry, which were treated prior to 1925, to determine the results of treatment and the incidence of malignancy among these cases. He found 82 cases available for study, and of these six died of metastases. Examination of the histories of these six cases shows that the first case was not an undoubted case of giant-cell tumor, and there was only a clinical diagnosis of metastases to the lungs without x-ray or autopsy proof. In the second case, there was no x-ray or autopsy proof of metastases to the lungs. Pneumonia and cardiac decompensation were also considered as the cause of death. The third case had biopsy proof of the original lesion. The patient improved after high voltage x-ray therapy, and died eight years later. Autopsy showed osteogenic sarcoma of the femur with metastases in the lungs. The fourth case was the one reported by Stone and Ewing and has been described above. The fifth case has an indeterminate history and poor microscopic sections. It could not be called a proved case. The sixth case had no x-ray films. The committee thought the specimen typical of giant-cell sarcoma. The patient died, presumably of metastases, four years after curettage.

From the above summary it can be seen that Cases 3 and 4 have fairly good proof that they were giant-cell tumors that became malignant, though Case 4 is challenged by Geschickter and Copeland (8).

Dyke (5) has reported a giant-cell tumor of the knee which was treated by curettage, establishing the diagnosis microscopically. Three years later the knee became markedly swollen following an injury, and amputation was performed. Later, death resulted from generalized metastases and at autopsy the metastases were found to be identical with the original growth. From this report, the case would appear to be one of true giant-cell metastasis, and not osteogenic sarcoma. No radiation therapy was applied in this case.

In 1932, Peirce (19) reported two cases which were apparently malignancy in conjunction with giant-cell tumors. One case occurred in a boy 17 years of age, who had suffered an injury to the left lower chest. Nine months later there was a large firm mass present, and roentgen study suggested a destructive neoplasm of the tenth and eleventh ribs. Deep x-ray therapy was applied over this area, and six weeks later a thoracotomy was performed, the entire mass being removed. The pathological diagnosis was "a combination of osteogenic sarcoma and giant-cell sarcoma arising in giant-cell tumor." The second case was that of a male, 45 years of age, who had sustained an injury to the left hip nineteen years previously, with the development of a mass on the inner side of the thigh about a year later. Examination on admission showed a large lobulated tumor of the left ilium and ischium, giving the appearance of a giant-cell bone tumor with a malignant upper portion which suggested chondrosarcoma. The lungs showed round shadows suggesting metastatic sarcoma. Biopsy report: "Giant-cell tumor with high degree of cellularity." Under x-ray therapy the

patient improved clinically, but was traced only seven months. In the first case the probable sequence of events was a primary giant-cell tumor of the rib, which was later converted into an osteogenic sarcoma. Injury may have been the inciting factor. The x-ray therapy did not enter into this part of the picture. The second case is not clear-cut, but probably is one of development of malignancy in a pre-existing giant-cell tumor, coming on after an old injury.

Coley (3), in 1935, discussed malignant changes occurring in giant-cell tumors and strongly charged that primary benign giant-cell tumors do change in character to malignant metastasizing tumors. He estimated that about 15 per cent of tumors, diagnosed as benign giant-cell tumors by experienced pathologists, later become malignant. He reported 19 cases, in which he presented various forms of evidence of an original diagnosis of giant-cell tumor. These all subsequently developed malignancy.

In attempting to determine a possible cause for the development of malignancy in a previously benign tumor, one must consider the various factors which may be involved. Many have tried to predict the development of malignancy from the cell type in the original benign tumor. Simmons (25) came to the conclusion that the cell type was of little clinical importance. He states that the appearance of the tumor varies according to the age of the tumor, previous treatment, and trauma. In 19 of the cases he studied, some question arose in the minds of the examiners as to presence of malignancy at the time of the first biopsy. The results in these cases, however, were the same as those in which no doubt arose. Geschickter and Copeland (8) state that in a few instances unsuccessful treatment or trauma, to a benign tumor, may by its failure to heal, provide a fertile field for the subsequent development of osteogenic sarcoma. The nature of the original lesion is not the important factor.

Stone and Ewing (27) in their report state that the malignant transformation in their case came as a result of various insults in which curettage and imperfect irradiation probably played the leading part. They advise against the insertion of radium into the tumor cavity and are in favor of the use of external irradiation. Coley (3) states that the patient with an apparently cured giant-cell tumor should be cautioned to avoid any local trauma.

Some authors have attempted to prove that radiation therapy may be the inciting cause in the development of osteogenic sarcoma in a previously benign giant-cell tumor. Coley (3) reported 19 cases of giant-cell tumors that were supposed to have become malignant. Most of these cases, at one time or another, had had radiation therapy. He, therefore, came to the conclusion that radiation therapy may have had some influence in producing the malignancy. A critical study of his cases would seem to indicate that 11 of them had had an undiagnosed malignancy when first seen and before any therapeutic measures were instituted.

Becker (1) collected 15 cases from the literature in which sarcoma developed subsequent to irradiation of tuberculous knees. The diagnosis of tuberculosis was made histologically in only two cases, the spindle-cell sarcoma developing from three to twelve years after the application of the roentgen therapy. From the lack of exact details of the cases in this report, it is difficult to determine what rôle radiation therapy may have played in the occurrence of the malignancy.

Martland (17) studied the occurrence of osteogenic sarcoma in radio-active watch dial painters. In 18 deaths among these people, five of them were caused by osteogenic sarcoma. Among 30 living dial painters who were radio-active, four had osteogenic sarcoma. In these cases the sarcoma always started in some area that was previously the site of radiation osteitis, the osteitis being of the osteoporotic type in contradistinction to the productive or sclerotic osteitis described by Ewing (7) and Phemister (23) following the external type of irradiation. Martland believes

the secret of the development of sarcoma in these cases lies in the intense destructive effects of the bombardment of the alpha particle and in this alone. He states that anything approaching sarcomatous transformation in cases of osteitis caused by external irradiation has never been recorded. The effects of filtered external irradiation and those of internal irradiation, such as these present, are entirely different and cannot be compared.

Sabin, Doan, and Forkner (24) injected radium chloride and mesothorium intravenously into rabbits once a month. The storage of the radio-active material in the bones gave rise to osteogenic sarcomas in two out of seven rabbits surviving from eleven to nineteen months. This seems to prove Martland's clinical study.

In order to determine the relation of the various forms of therapy to the cases of malignant variation of giant-cell tumors reported in the literature, a study of this subject was made. Peirce (19) reported two such cases, in both of which malignancy was present before any form of therapy was administered and both had a history of previous local injury. Chatterton and Flagstead (2) also reported two cases which followed repeated injury, neither of which seemed to be related to any form of therapy.

In the case reported by Dyke (5), the malignancy developed after injury and curettage and later amputation. MacGuire and McWhorter (16) reported 20 cases of giant-cell tumor, of which four died of malignant metastases. One of these four cases was treated by curettage followed by recurrence, followed, in turn, by a second curettage and the application of radium inside the cavity and roentgen therapy outside. A second recurrence preceded amputation and eventual death. The other three cases were treated by curettage followed by amputation, radiation therapy not being applied.

In the case reported by Stone and Ewing (27), the malignancy followed curettage and radiotherapy in which the radium was placed in the tumor cavity. These authors believe that radium should never be placed in the tumor cavity as it produces an osteitis which interferes with normal recalcification. In the report by Simmons (25), there was one case of malignancy which had been treated by roentgen therapy, the patient dying seven years later of metastases. Another had had both curettage and radiotherapy, later dying of metastases.

Among the cases reported by Coley (3) which, from the evidence submitted, appear to have been giant-cell tumors that later became malignant, we find various types of therapy employed. In seven cases surgery was used as a therapeutic agent, and six of these same cases also had radiotherapy. One case had surgery only, and one had radiotherapy only. Two of these cases also had toxins.

CASE REPORTS

Case 1. J. N., female 21 years of age, reported for examination in April, 1934, complaining of pain and swelling of the right foot and ankle. A history was given of a blow to the right ankle in June, 1933, with gradually increasing discomfort and swelling so that by November, 1933, she was forced to walk with the aid of crutches. X-ray films were taken at that time at the request of the family physician and the patient was advised that there was bone destruction and that she was to continue walking with crutches. Her general health had remained excellent and there was no loss of weight or elevation of temperature.

Examination on admission to this hospital revealed atrophy of the right calf and considerable swelling about the malleolar region of the right ankle, more marked over the medial malleolus. Movements of the ankle and mid-tarsal joints could be carried out normally. There was tenderness on pressure, and increased heat over the medial malleolus and lower three inches of the tibia. The swelling over the malleolus was soft and spongy.

X-ray examination of the ankle revealed evidence of a cyst-like tumor involving the lower three inches of the right tibia. The normal bone detail in this area was en-

(See legends on opposite page.)

tirely destroyed; the cortex was markedly expanded and in some places appeared to be absent, giving the typical appearance of giant-cell tumor.

A punch aspiration biopsy of the interior of the bone was obtained, the pathological report on which was as follows: "The section consists of small bits of tissue composed of oval or round cells with many large giant cells of the foreign body type scattered throughout. There is nothing to suggest malignancy: benign giant-cell tumor."

X-ray therapy was administered as follows: May 10, 1934: two portals of entry, 190 kv., 0.5 mm. Cu + 1.0 mm. Al filtration, 50 cm., F.S.D., 520 r units over each portal. This was repeated Aug. 20, 1934, and again Nov. 21, 1934.

Because of failure of the tumor area to show much recalcification and because an area of decreased density had developed in the lower end of the fibula which suggested tumor formation, the tumor was explored in December, 1934. Grayish-yellow friable tumor tissue was encountered immediately beneath the subcutaneous tissues, and extended within the shell of bone. The interior of the bone was thoroughly curetted and the wound closed. Pathological report of the tumor removed was as follows: "Sections from curettings show for the most part the typical histological picture of giant-cell tumor, *i.e.*, numerous large giant cells of the foreign body type with ten to fifteen nuclei and a stroma composed of oval or short spindle-shaped cells. In some sections, however, particularly those from deep within the tumor tissue, the stroma cells tend to become more of the adult type. The cells are more elongated and have more cytoplasm and the nuclei are hyperchromatic, many of them undergoing mitosis. In these same areas the stroma cells have undergone malignant change in that there is marked variation in the size and shape of the cells, the nuclei are hyperchromatic, and many of them are grouped together forming true tumor giant cells. At the present time it must be considered histologically malignant."

Amputation was recommended, but the patient's family would not give their consent. Further roentgen therapy was given on April 1, 1935, and again on July 3, 1935. The latter was given because of the lesion's extending upward in the shaft of the tibia.

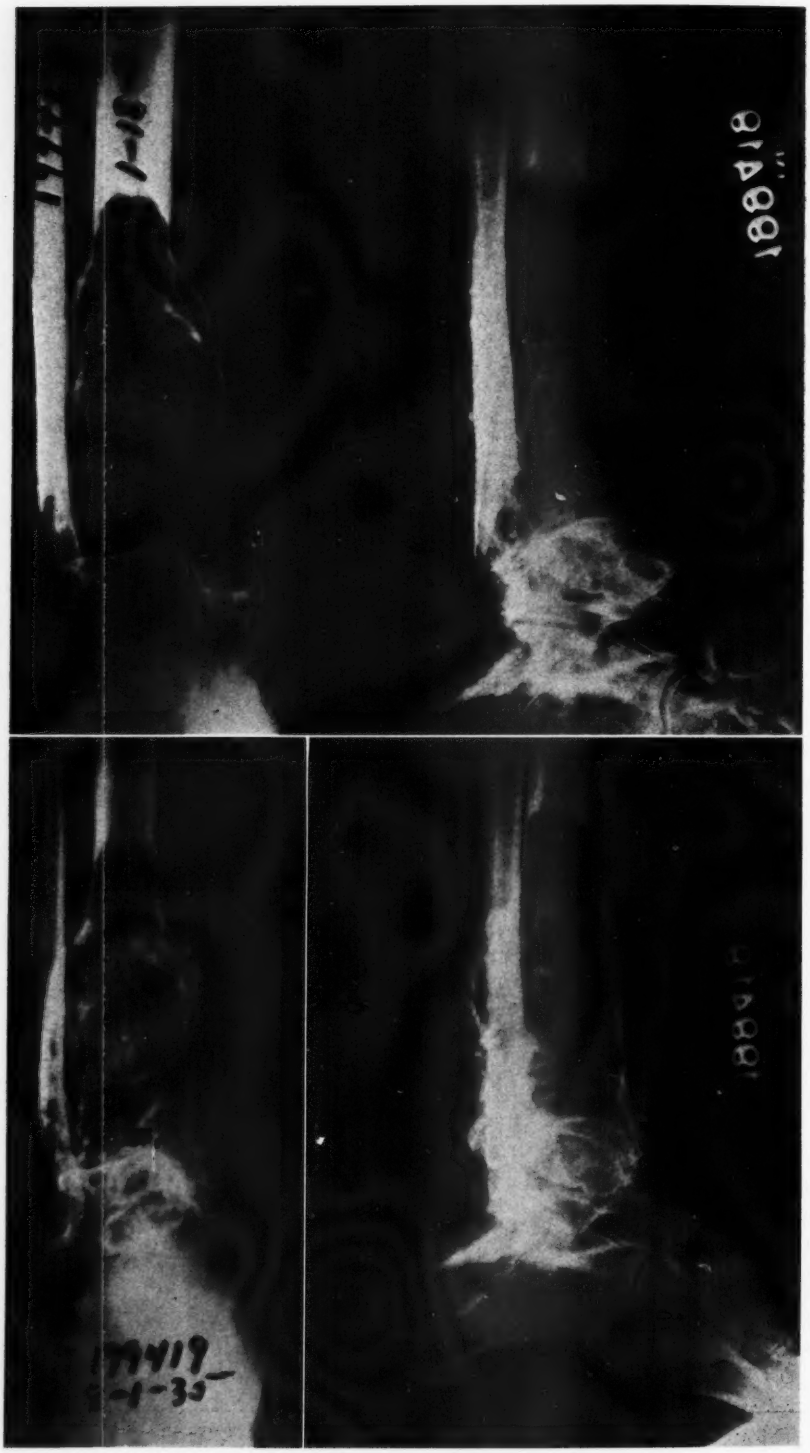
Examination in September, 1935, revealed a soft tissue swelling over the external malleolus and a biopsy of this area was obtained. The pathological report on this was as follows: "Section from the lower end of the fibula shows considerable dense, pink staining, fibrous stroma with cellular areas scattered throughout. The sparsely nucleated and richly nucleated tissue is arranged in interlacing whorls and columns. The more cellular areas are composed of long spindle-shaped, oval, or round cells. Here the cells are much larger, have abundant cytoplasm and hyperchromatic nuclei. Mitotic figures in these areas are fairly abundant, three being seen in a simple high power field. There are no giant cells or characteristic stroma of giant-cell tumor which would suggest that this tumor arose in a giant-cell tumor of bone. It is a typical fibrosarcoma of rather above the average activity."

Permission for amputation below the knee was obtained and carried out on Oct. 23, 1935. Palpable inguinal glands were removed at operation two weeks later and metastatic involvement found on microscopic examination. X-ray therapy was subsequently given over the right groin.

X-ray films of the chest were negative for metastatic malignancy. The patient was last seen June 5, 1937, when examination revealed no evidence of recurrence of the tumor.

Case 2. M. D., 14 years of age, male, was admitted June 29, 1935, complaining of a painful swelling over the left hip. A history was given of a fall on the left hip while pole-vaulting two months previously.

Fig. 1 (*upper*). Case 1. Typical giant-cell tumor before radiation therapy (April 30, 1934).
Fig. 2 (*lower*). Case 1. Roentgen appearance six months after beginning radiation therapy. Partial recalcification of the tibia. Evidence of a destructive process in the external malleolus.



(See legends on opposite page.)

Pain appeared two days later and continued intermittently until two weeks prior to admission, when it became more severe and constant, and swelling was noticed for the first time.

Examination revealed no abnormalities other then the findings relative to the left hip and ilium. There was a visible mass involving the left side of the pelvis which, on palpation, was found to be firm and fixed to the crest and wing of the ilium. In extent it reached laterally and downward to within a short distance of the greater trochanter, backward from the anterior superior spine for a distance of five inches along the crest of the ilium, and mesially to within two inches of the umbilicus. The hip joint was freely movable without pain.

X-ray films of the left ilium revealed a cyst-like tumor involving the entire left ilium with a tumor mass, roughly oval in shape, extending laterally into the soft tissues. Along the medial border of the tumor there was evidence of invasion of the ilium, suggesting that there was malignancy present.

On July 3, 1935, operative exposure of the tumor was carried out. The tumor tissue was found to be friable, grayish in color, and extremely vascular. Microscopic examination of the frozen sections suggested giant-cell tumor. An attempt was made to curet the tumor mass, but this was abandoned because of the extensive hemorrhage encountered.

The pathological report on the sections was as follows: "Sections taken from bits of tissue removed show the same composed chiefly of giant cells of two distinct types, the first being the usual foreign body type with abundant pink staining cytoplasm and many round or oval nuclei. The second type of giant cell is the typical tumor giant cell with one or more irregular hyperchromatic nuclei. In some of these latter giant cells the nuclei are undergoing mitosis. Aside from the giant cells there are many tumor cells of varying size and shape distributed throughout the rather scanty stroma. The number and type of giant cells and tumor cells vary from microscopic field to microscopic field. In some the tumor giant cells predominate and in others the foreign body giant cells predominate. Diagnosis: osteogenic sarcoma with tumor giant cells and foreign body giant cells, probably arising as a variant of the giant-cell tumor."

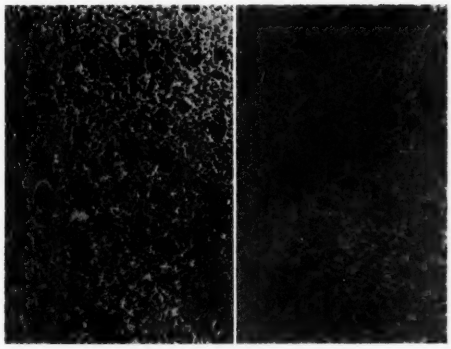


Fig. 5 (*left*). Case 1. May, 1934, first biopsy showing many large multi-nucleated giant cells of foreign body type with a stroma of small oval or spindle-shaped cells. Benign giant-cell tumor.
Fig. 6 (*right*). Case 1. Material from operation. There are a few giant cells of foreign body type but with the stroma definitely sarcomatous and composed of spindle cells of varying size and shape arranged in whorls. Mitotic figures are abundant. Osteogenic sarcoma.

Treatment consisted of five series of roentgen therapy applied through three portals of entry, anteriorly, posteriorly, and laterally. The factors used were 200 kv., 50 cm. F.S.D., 0.5 mm. Cu + 1.0 mm. Al filtration, 700 r units. This was repeated on five different occasions between July 15, 1935, and Oct. 5, 1936. Preceding and interspersed between these treatments he was given artificial fever therapy. His body temperature was raised to approximately 105° F. (rectal temperature) and maintained at that level for five-hour intervals on twelve occasions.

Fig. 3 (*upper*). Case 1. Jan. 18, 1935, eight months after radiation therapy. Increasing recalcification in the tibia. Extension of the destructive process in the external malleolus.
Fig. 4 (*lower*). Case 1. Aug. 1, 1935, showing considerable recalcification in the tibia. Destruction of fibula more advanced.

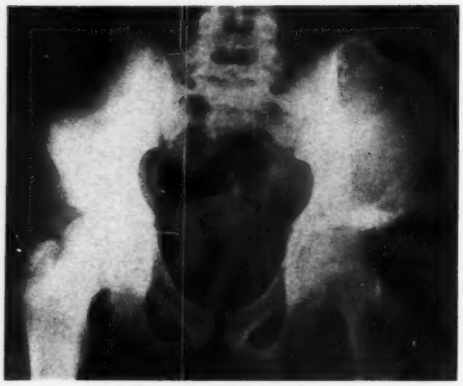


Fig. 7. Case 2. Cyst-like tumor of the left ilium with evidence of invasion along the medial border suggesting beginning malignancy in that area.

X-rays of the pelvis taken in October, 1936, revealed the tumor to have decreased slightly in size from the original examination, the margins were more clearly outlined, and there was partial recalcification. No new areas of bone destruction were noted. X-ray films of the chest were negative for metastatic malignancy.

When last seen in November, 1936, the boy was unable to walk because of pain. There had been moderate weight loss, and anemia was quite pronounced. The tumor mass had decreased slightly in size. The boy's father reported in February, 1937, that the patient was receiving "serum" treatment and was "holding his own," but required opiates constantly for pain. Death occurred in July, 1937.

Case 3. M. S., 33 years of age, female, reported to the clinic in July, 1929, complaining of pain and swelling in the left knee. Symptoms had been present and gradually increasing in severity for seven months. No history of injury was obtained. The condition had been diagnosed as rheumatism and treatment had consisted of physiotherapy.

Examination revealed an asymmetrical swelling immediately above the left knee with the maximum swelling on the mesial aspect of the thigh opposite the internal condyle. There was marked tenderness to palpation and the swelling was soft and fluctuant.

X-ray examination revealed evidence of a destructive lesion involving the lower end of the femur beginning at the knee joint and extending upward for a distance of about three inches. The destruction was most marked in the internal condyle and there was some expansion of the cortex, with apparent destruction of the cortex in several places. There was evidence of some soft tissue swelling around this.

At operation (Aug. 1, 1929) friable yellowish tumor tissue was encountered outside of the cortex—the cortex was extremely thin and was broken through in several places. The interior of the femur was thoroughly curetted and carbolized.

Pathological report was as follows: "Sections are composed of cellular tumor growth made up of dense stroma which is composed of oval and spindle-shaped cells with evenly stained nuclei and rather irregular amounts of cytoplasm. Scattered throughout this cellular stroma there are many large, irregular giant cells. These have a large amount of pale eosin-staining cytoplasm and numerous nuclei scattered throughout. They vary in shape and most of them are rounded or polyhedral. Some have as many as fifty or more nuclei. There is associated with this tumor some inflammatory reaction both acute and chronic in type." Pathological diagnosis: giant-cell tumor.

The patient had post-operative roentgen irradiation to the tumor area as follows: Aug. 9, 1929: Two portals of entry, 190 kv., 50 cm. F.S.D., 0.5 mm. Cu + 1.0 mm. Al filtration, 650 r units. Other series of roentgen therapy were applied in October, 1929; January, 1930; June, 1930, and September, 1930.

Progress x-ray films were taken at frequent intervals following operation and by February, 1930, the tumor was found to have decreased in size markedly and there was considerable recalcification of the tumor area.

X-ray films taken in March, 1932, revealed excellent recalcification and a sug-

gestion of a fracture line through the tumor area.

The patient was not seen again in the clinic until April, 1934. X-ray films taken at that time revealed a complete fracture of the femur at the upper level of the tumor with telescoping of the shaft through the tumor area. This condition has persisted since then. The patient is able to walk without external support and without discomfort, and has refused further surgery.

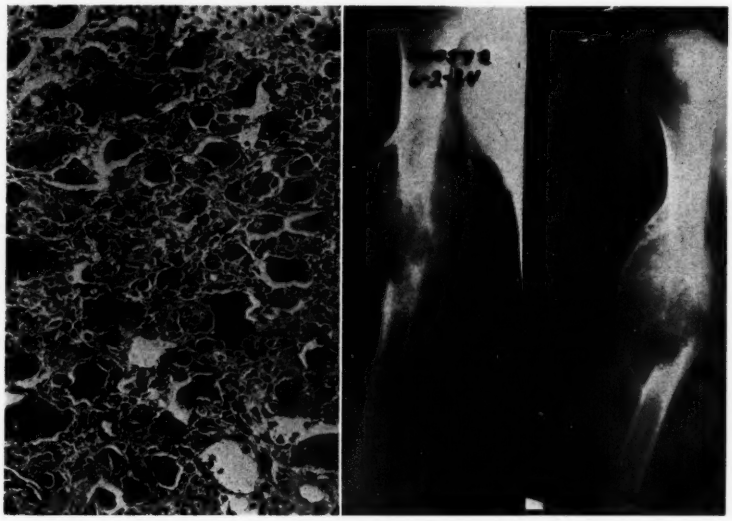


Fig. 8. Case 2. The tumor is made of large foreign body giant cells. The stroma cells are sarcomatous. They vary in size and shape and many are undergoing mitosis. Osteogenic sarcoma in giant-cell tumor.

Fig. 9. Case 5. Cystic lesion of left humerus before radiation therapy.

Case 4. A. T., male, 40 years of age, was admitted Dec. 22, 1933, complaining of pain in the left knee. A history was given of a blow over the medial condyle of the femur by a chassis frame two months previously. There was no immediate disability, but he continued to have discomfort in the knee following the accident. On one occasion the knee gave way from under him, but there was no history of locking. Examination of the left knee on admission revealed a visible swelling immediately above the knee joint on the mesial aspect. The range of motion in the knee was normal and there was no increase in joint fluid. There was a palpable enlargement of the inner condyle of the femur and slight tenderness on pressure.

X-ray examination revealed a large area of decreased density representing a cyst-like condition in the internal condyle of the femur. There was some trabeculation present throughout this area. The cortex was intact and the contour of the lower end of the femur was normal, suggesting a benign giant-cell tumor.

Operation was performed on Dec. 27, 1933. The cortex over the internal femoral condyle was extremely thin and broken through easily. The interior of the bone was found to be filled with tumor tissue, which was vascular and grayish in color. This was thoroughly curetted, removing as much of the tumor tissue as possible. Microscopic examination of this tissue was as follows: "Section shows a dense fibrous stroma made up of spindle cells mixed with somewhat rounded cells having oval or rounded vesicular nuclei, and throughout the stroma are distributed numerous large foreign body giant cells with from five or

six to as many as 30 or 40 nuclei. In one area there is considerable hemorrhage, which is characteristic of the tumor. Mitotic figures are very infrequent. Pathologic diagnosis: Benign giant-cell tumor."

Roentgen therapy, Jan. 8, 1934: Two portals of entry, 200 kv., 0.5 mm. Cu + 1 mm. Al filtration, 50 cm. F.S.D., 550 r units. This dosage was repeated on March 5, 1934, and again on Nov. 9, 1934.

Recalcification of the tumor area progressed slowly but steadily. At the time of the last roentgen therapy, however, there was a large cavity that had not recalcified. At the time of the last roentgen examination in November, 1936, recalcification had largely filled in the cystic area. At the present time the patient is symptom-free and is doing heavy work without discomfort.

BONE CYST

The solitary bone cyst is found most frequently in young persons, usually under twenty years of age. The sites of election are the upper portions of the shafts of the humerus, femur, and tibia. It may occur, however, in any of the long bones.

In most cases the clinical findings are not important, and the patient is often unaware of the existence of any pathologic condition. In many cases, a pathologic fracture brings the patient to the physician.

The roentgenologic picture is that of a centrally placed area of bone destruction in the metaphysis of the bone, with a fusiform expansion of the cortex which may be of paper-like thinness. The cortex is usually intact, except where there is a pathologic fracture through this area. Trabeculæ are not as prominent or numerous as in giant-cell tumor. On section, the cavity is usually found to contain a thin fluid, but there may be fibrous tissue present. The cavity usually has a connective tissue lining.

In small symptomless solitary cysts, no treatment may be necessary. Those in which pathologic fraction has occurred frequently fill in with bone as the fracture heals. In larger acute cysts, roentgen therapy is the method of choice, in the opinion of Geschickter and Copeland (9), who advise moderate doses. Le Wald (15) has reported several cases in which roentgen therapy was very effective in obliterating bone cysts.

In dealing with multiple cystic lesions or osteitis fibrosa cystica, we have a condition which is now generally conceded to have an endocrine etiology. It is associated with hyperparathyroidism, and has a definite clinical syndrome. There may or may not be an associated adenoma of the parathyroid gland. There is usually an elevation of the serum calcium, a lowering of the serum phosphorus, and an increase in the excretion of calcium. There may be deposition of calcium in the kidneys. The bones are generally demineralized, and there is sometimes a characteristic roentgen picture in the skull, spine, and long bones.

The surgical treatment consists in extirpation of the tumor of the parathyroid gland if present, or of a portion of the hyperactive gland. Irradiation of the parathyroid glands has been reported by Merritt and Lattman (18) and others. This has resulted in improvement or disappearance of the osseous lesions.

CASE REPORT

Case 5. I. B., female, 17 years of age, was seen in June, 1934, because of a swelling of the left arm which had been slowly progressive since December, 1933. Pain and tenderness had been prominent features in the early stage but recently had subsided. Treatment had consisted of local applications and chiropractic adjustments.

Examination disclosed a fusiform swelling at the level of the junction of the upper and middle thirds of the left arm. This was of bony hardness and slightly tender on deep palpation. The x-ray examination showed an expansile cystic process in the upper half of the left humerus. The tumor measured 5.5 cm. by 10 cm. in its greatest diameters. It contained numerous bone trabeculations throughout its extent and had fairly well defined margins.

Laboratory examination showed a normal urinalysis; hemoglobin, 68 per cent; red blood corpuscles, 4,210,000; white blood corpuscles, 7,100; polymorphonuclears, 69 per cent; Wassermann, negative; serum calcium, 9.8; phosphorus, 3.84; phosphatase, 8.30.

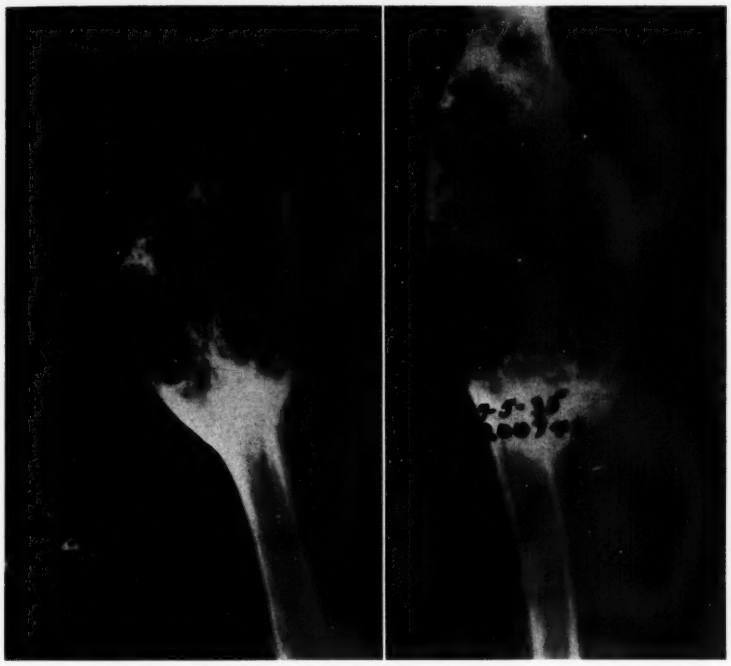


Fig. 10. Case 5. Considerable recalcification of the tumor eleven months after beginning radiation therapy.

June 9, 1934, an exploratory operation was performed. The cortex of the humerus was extremely thin and easily broken through. The large cavity which was thus entered contained nothing but some blood clots. The interior was curetted but only blood was obtained. A portion of the shell-like cortex was removed for biopsy. Report on the pathologic examination was as follows: "Sections from wall of cyst removed shows thin, pink-staining, sparsely nucleated, fibrous tissue with occasional giant cells scattered throughout and some trabeculæ of bone. There is nothing to suggest malignancy or giant-cell tumor. Pathologic diagnosis: Benign bone cyst."

The wound healed *per primum*, and to obviate the possibility of a pathologic fracture, a platform splint was applied. Roentgen therapy was given as follows: (Aug. 21, 1934) two portals of entry, 190 kv., 50 cm. F.S.D., 0.5 mm. Cu + 1.0 mm. Al filtration, 500 r units. Similar amounts of roentgen therapy were applied on Nov. 19, 1934, and April 20, 1935.

X-ray films taken Nov. 19, 1934, and subsequently, revealed a progressive amount of recalcification of the cyst. The patient returned to school and had no further discomfort in the arm until March, 1936. X-ray films taken at that time, however, showed no decalcification. She returned for observation one month later with increased pain in the left arm, and on clinical examination the arm was found to be increased in circumference, with a painful soft area on the lateral aspect of the tumor. X-ray films revealed an area of decalcification and destruction along the anterior surface of the tumor mass. The

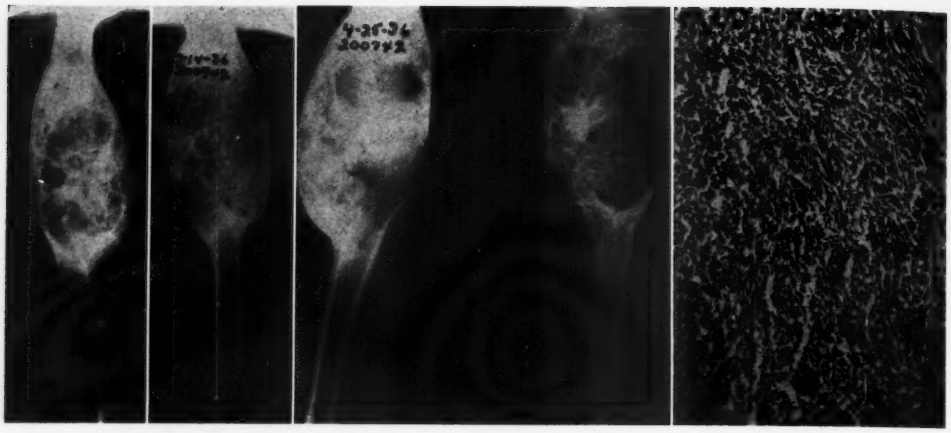


Fig. 11. Case 5. Condition of tumor twenty months after the first radiation therapy (March 14, 1936).
Fig. 12. Case 5. Evidence of malignant destruction of the cortex seven weeks following the previous film.
Fig. 13. Case 5. From tumor mass arising in bone cyst. The tumor is composed of spindle cells of varying size, and tumor giant cells. Mitotic figures are abundant and hemorrhage is present about the blood vessels. Osteogenic sarcoma.

cortex in this portion was missing and there was evidence of a soft tissue tumor around this area. It definitely suggested malignant tumor. X-ray films of the chest were negative for malignancy.

On April 27, 1936, the arm was again explored and tumor tissue encountered immediately beneath the subcutaneous layer. Pathologic examination of this tissue revealed: "Tumor tissue composed of rather loosely packed, plump, oval, and spindle cells which vary markedly in size and staining reaction. The largest cells present hyperchromatic and vesicular nuclei and rather abundant eosinophilic, finely granular cytoplasm. Giant cells of the tumor variety are rather frequently seen. The tumor giant cells have from two to four or five nuclei, some of which are very large and bizarre in appearance. The foreign body giant cells have many nuclei and the usual central grouping. Mitotic figures are fairly common and when they occur are atypical. No bone formation or osteoid tissue formation is seen. Pathologic diagnosis: Osteogenic sarcoma."

Subsequently roentgen therapy was given as follows: 200 kv., 50 cm. F.S.D., 0.5 mm. Cu + 1.0 mm. Al filtration. From 200 to 250 r units were applied to each of two ports on alternate days until approximately 2,200 r units had been applied to each port.

The tumor did not regress following this therapy. X-ray examination of the chest on Aug. 10, 1936, revealed evidence of metastatic tumor nodules in both lungs. The patient expired at home Sept. 3, 1936.

CHONDROMA

A chondroma is a benign centrally placed lesion occurring most frequently in the small bones of the hands, feet, ribs, or spine: it may occur in the other long bones, or flat bones. In most instances, it is found in young adults. The tumor is very slow-growing, and may appear to be stationary. The symptoms are mild, and may consist of soreness or tenderness over the affected area.

The roentgen picture is that of a cyst-like tumor, centrally placed. The cortex is thin and unbroken. Trabeculæ traversing the tumor is the usual finding. They present a picture similar to that of bone cyst or giant-cell tumor except for their point of origin, which is commonly in the small bones of the feet and hands. They are usually oblong in shape, and extend

along the medullary canal. These tumors are composed primarily of cartilage, and when sectioned have the typical gelatinous appearance seen in cartilaginous growths. In small tumors, they are apt to be rather solid and contain some calcification. In the large specimens, cystic changes may be present, and these cystic areas contain a thick fluid. The tumors are relatively avascular.

Benign chondromas have always been regarded as relatively radioresistant and, therefore, few attempts have been made to treat them by radiation therapy. In tumors of small bones, resection or curettement followed by cauterization usually effects a permanent cure. Geschickter and Copeland (9) state that in their series of, chondromas occurring in the large bones, recurrences after operation totaled 25 per cent. They believe that in cases in which complete removal is difficult or dangerous, irradiation should be used. Desjardins (4) reports one case in which radiation therapy distinctly relieved pain, and the x-ray appearance of the tumor was improved. We have treated one case which showed some recalcification, but no complete disappearance of pain and tenderness.

Case 6. H. R. S., white female, 23 years of age, was first seen in 1933, complaining of a pain in the right shoulder. This was aggravated by carrying heavy objects. There was increasing weakness of the right arm.

Physical examination revealed no deformity of the shoulder or upper extremity: no limitation of motion. The maximum point of tenderness was over the acromion process of the scapula.

Roentgen examination disclosed a cyst-like tumor of the acromion process of the scapula, with marked expansion of the cortex. The cortex was intact. The first impression was that it was a benign giant-cell tumor.

Roentgen therapy was applied on four different occasions at intervals of from two to four months. The factors used were: 200 kv., 0.5 mm. Cu + 1.0 mm. Al, 50 cm. F.S.D. The dosage varied from 550 r to 600 r through each of two portals.

The pain and weakness persisted unless the arm was put at rest with support, and it was finally decided to surgically explore the tumor. The lesion was thoroughly curetted and cauterized with phenol on Oct. 16, 1935. The material removed was white and cartilaginous. Pathologic diagnosis: Benign chondroma.

The patient gradually improved following the operation. The improvement has been gradual but steady, and at this time the arm is in full use, with very few symptoms.

SUMMARY

The major portion of this discussion has been devoted to the technic and results of the application of radiotherapy to giant-cell tumors of bone. The recorded statistics tend to show a high percentage of cured cases resulting from this method.

There is an increasing number of cases reported in the literature in which there is a transition from benign giant-cell tumor to osteogenic sarcoma. The etiology of this transition is not clear at this time, but injury or chronic irritation occupies an important place in these case histories. It is difficult to determine whether or not radiotherapy is a factor in this process, owing to the small number of carefully studied cases available for review. Malignant variants, however, are being recorded more frequently during recent years. Whenever metastases are found they show the histology of osteogenic sarcoma and not of the original giant-cell tumor.

In our case, reported above, a typical giant-cell tumor of the lower tibia received several series of roentgen therapy. After several months an osteolytic area was noted in the external malleolus. Biopsy of this disclosed evidence of fibrosarcoma, and metastases also were histologically fibrosarcoma. This illustrates a case in which transition from benign giant-cell tumor to fibrosarcoma occurred during conservative roentgen therapy. What rôle this therapy may have played in the transition is open to question.

Since small, frequently repeated doses of roentgen therapy may have a stimulative

effect on the tumor cells, we raise the question of increasing our roentgen dosage to higher limits. This would necessarily mean that the time interval between the roentgen series would be lengthened and fewer doses be administered.

We believe that roentgen therapy and surgery should not be combined in the treatment of giant-cell tumors. The possibility of increased irritation resulting from such a combination may possibly be a factor in the transformation from a benign tumor to a malignant one. In several malignant variants reported in the literature such a possibility has been mentioned.

A short discussion of benign bone cyst has been presented, with special reference to roentgen therapy. One case is reported in which roentgen therapy was used. The cyst showed excellent recalcification but after eighteen months an osteogenic sarcoma developed which resulted in death to the patient. It is difficult to understand the development of osteogenic sarcoma in a case which calcified so well under roentgen therapy.

Benign chondroma is briefly discussed and one case is reported. This case received roentgen therapy and showed moderate recalcification but finally had surgical curettement. This again demonstrates that these cases are radioresistant and require large amounts of irradiation to destroy them.

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SKIN METASTASIS IN POST-OPERATIVE IRRADIATED BREAST CANCER[1]

By FREDERICK W. O'BRIEN, M.D., *Boston*

THE appearance of single or multiple metastatic skin nodules secondary to breast cancer is disquieting not alone to the patient but to the informed clinician because of his knowledge that it is a manifestation of a terminal process.

Since the advent of intensive fractionated high voltage x-irradiation and its rather universal utilization, one might expect from theoretical considerations to encounter secondary skin deposits in breast cancer, irradiated post-operatively, less frequently than formerly, or at least to have their appearance delayed.

Nevertheless they have continued in my clinic with disquieting frequency, so that it seemed of importance to survey them in an attempt to establish the chronological relationship, if any, between the kind of x-irradiation and the appearance of the metastatic skin nodule.

In a period of fourteen years (1923 to 1936, inclusive), 407 cases of pathologically proven breast cancer were operated upon at the Boston City Hospital. They constituted 0.3 per cent of the surgical admissions for that period. Of these breast cancers, 255, or 62.6 per cent, were treated post-operatively by x-ray.

Single or multiple skin nodules appeared in 54 of these 255 cases, or in 21.1 per cent. In 22 cases, or 41.7 per cent, skin metastases appeared on an average of 8.14 months after operative interference, which was frankly incomplete. In 32 cases, or 58.3 per cent, skin metastases appeared on an average of 14.6 months following the classical radical resection. There were 10 of these cases, however, that had palpable axillary and supraclavicular glands before operation and should not have been subjected to the radical operation. Skin metastases did not appear for an average of 18.5 months in the 22 cases without palpable nodes that were operated upon radically. These figures closely parallel those of Ackland (1).

On the face of it, these statistics indicate that the appearance time of skin metastasis in this group of breast cancers treated post-operatively by x-rays was directly related to the extent of the growth at the time of operation. There was no evidence that the kind of tumor influenced the appearance time of skin metastases. It was clear, however, that skin metastasis appeared with relative promptness following incomplete or injudicious surgery. Paradoxically, it would seem, in our reputedly enlightened age, 20 of the 22 frankly incomplete operations in the group were done since 1929.

The x-ray treatment was given on the average about four months after operation, not early enough perhaps but at least an improvement over the group reported earlier (2), in which in one-half the cases x-ray therapy was not instituted for more than ten months following surgery.

The majority of the cases showing secondary skin nodules had adequate x-ray therapy as judged by the mode of the era in which they were treated. The earlier ones were not irradiated in as thoroughgoing a fashion as is our wont to-day. Statistically there is no evidence that the appearance of skin metastasis was related to the kind or amount of irradiation but rather to the extent of growth and the kind of operation performed.

The latter statement holds as a generalization, but only a cursory experience with the subject forces one to the realization that other factors must influence the time of appearance of secondary skin deposits.

The two longest lived cases of the main group had radical operations and inadequate x-ray therapy, judged by any stand-

[1] Presented before the Fifth International Congress of Radiology, at Chicago, Sept. 13–17, 1937.

ard. One lived for thirteen years and the other is still living after twelve years. The former did not have skin metastases until twelve years after operation and the latter eight years after operation. Neither case was used in the computation of the post-operative appearance time of skin metastasis because it was felt neither represented "the run of the mill." Something beside surgery and radiation restrained the growth of the cancer cells in these two cases. Give surgery all credit, radiation can take none. Yet we can hardly think of surgery restraining cancer cell growth: rather, must we fall back on some process of cell growth peculiar to the tumor itself or to the natural resistance of the individual, each or both contributing to the establishment of an approximate equilibrium.

One of the two cases just referred to that lived the longest was definitely benefited by x-irradiation, once the skin metastases appeared, and that is true for the most part of the other members of the group, although my experience has been that when there has been regression of one set of skin nodules a set will appear elsewhere, and it is not long before pulmonary and skeletal changes take place, followed by exitus.

Once skin metastases are present, it matters little what was the route. On the other hand, if post-operative irradiation is to be continued, then many more fields must be employed than is generally the custom. It is not sufficient to treat the affected chest wall, axilla, and clavicular chain of lymphatics, but it is quite as necessary to treat the mediastinum and the lymphatics of the opposite breast over a protracted period with a view to slowing up the growth of any remaining cancer cells, in the hope that, if implanted elsewhere, they may be less viable.

If post-operative irradiation is of any value in inhibiting cell growth and the distribution of cancer emboli, pre-operative irradiation ought to be of greater value, for with the breast and axilla intact, larger amounts of radiation may be administered to these areas without damage to the chest wall and axillary vessels.

It has been shown that one-third of the cases of cancer of the breast can be sterilized by x-irradiation and that, properly administered, pre-operative irradiation does not erect barriers to effective radical surgical intervention.

Master surgeons confess that there is little likelihood of any change in surgical technic that will alter the percentage rate of present-day survivals. If that is the case, some group must have the courage to endorse pre-operative irradiation conceived broadly—not for the glorification of radiology but in a serious effort to evaluate once and for all whether this added pre-operative therapeutic routine will measurably assist in prolonging in comfort the lives of these cancer patients.

Such a program will presuppose an efficiently functioning tumor clinic where internist, pathologist, radiologist, and surgeon will have a common understanding of the problem confronting them, where proper diagnostic x-ray and blood studies may be done, where the pathologist may help chart the course of the radiologist and the experienced surgeon will foil the less experienced who would elect unwise, unradical procedures.

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THE BIOLOGIC BASIS OF THE FRACTIONATED METHOD OF IRRADIATION OF MALIGNANT TUMORS[1]

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ON January 15, 1897, Leopold Freund reported to the Wiener Gesellschaft der Aertzte that roentgen rays could be used for therapeutic purposes.

Freund's demonstration was of the greatest importance in the start of roentgen therapy, and has remained of great significance for other reasons. Freund used as a method of treatment of his first case, one of epilation for nevus pilosus, the one which, one may say in retrospect, has survived all other technical procedures introduced in the forty years of roentgen therapy.

The point of the procedure was that the patient was irradiated for two hours daily. The duration of the treatment for two hours was due to the low efficiency of the roentgen tubes, or, rather, the tubes that were used for roentgenologic purposes. Modern tubes produce the same roentgen-ray output in a few minutes. The fact that Freund treated his patient *daily* was not due to technical limitations entirely but is a characteristic of the procedure which we nowadays designate as a *fractionated* method of irradiation. The basic characteristic of the divided dose method of treatment is completely summed up in the following statement: "On the eleventh day, while making the child's toilet, the mother pulled out large bunches of hair." With that the first experiment ended.

The dividing of the dose was not done arbitrarily but it was continued up to the point of the onset of the desired radiation effect. For this reason Freund later designated his method "the continuation of small doses to the point of effectiveness" and thereby clearly stated its characteristics.

Freund's method of treatment is characterized by both the external and the internal aspects of fractionation which regulate the duration of the treatment, and so, the degree of the fractionation. The intensity and the duration of the individual doses depend on the onset of the radiation effect for which one is seeking.

Freund is, therefore, to be regarded not only as the founder of roentgen therapy but also as the originator of the method of treatment which to-day is known as "fractionated irradiation for a long time" (*fraktionierte Lanbestrahlung*) or as "long-time-irradiation" (*Langzeitbestrahlung*) (Schinz, Holthusen).

It was not possible to establish a biologic basis for this method of irradiation in these early days of roentgen therapy. It probably was the same as that ruling all conservative practice of medicine, whether it embraces the use of medical or physical media—the use of the agent up to the point of emergence of the desired effect.

Even though this method of procedure is so well established in both medical and physical therapy that it seems to be almost axiomatic, this same method of procedure in roentgen therapy has developed into one of the most important controversies in the whole roentgeno-therapeutic field.

The first comprehensive experimental work on the problem was reported by Friedrich and Kroenig in 1919. These authors irradiated in one sitting one side of the abdomen with a predetermined dose. The other side of the abdomen

[1] Read at the meeting of the Wiener Gesellschaft der Aertzte, Jan. 15, 1937.

received the same dose in thirteen fractions, given on thirteen consecutive days. These authors also carried out similar experiments with radium. Both series of experiments led to the same conclusions, summarized by the authors as follows: "A dose applied in a single sitting has a much more definite biologic effect on the surface of the skin than the same dose has if divided."

All experimental work on this subject substantiated these conclusions and elaborated them in certain details. For example, Schwarz showed that interruption of the irradiation for a few hours only led to the production of a weaker erythema reaction. Other investigators, Liechti, in Germany, and Stenstrom and Mattick, in the United States, gave estimates of the degree the total dose would have to be increased, if divided, to produce the same effect as if given at one time. Reisner did some comprehensive experiments on this problem. He showed, for example, that if the 100 per cent skin erythema dose is not given in one session but is given in divided doses, then at the end of two days 130 per cent, in three days 150 per cent, and in seven days 210 per cent of the erythema dose will have to be given to produce an erythema reaction. In summary, the smaller the individual dose, the greater the irradiation intervals, so much more will the total dose have to be increased to produce the same effect as that from irradiation given in one session.

It has been found out that these observations are valid in the case of tissues other than the skin. Wintz made similar observations on the ovary. In 1926, I reported, apparently as the first, some observations on the decreased effect of divided doses on the hair as shown by some experiments on rabbits, some observations which were later confirmed by Miescher and Gunsett. These experiments showed that even a few hours' interval definitely decreases the effectiveness of irradiation, and that the dose must be increased to get the initial effect.

Wintz, in 1920, first gave a theoretical explanation for this course of events. "We explain this fact in this manner . . . the cells are only injured by insufficient irradiation and are not killed off. In the time to the next irradiation, which is to increase the effect of the first dose, the cells recover rapidly. The second dose of radiation is given to cells in a different condition from that which they were in shortly after irradiation, and are cells which have recovered more or less completely from the dose. To each successive dose an increment of energy must be added which depends on the recuperative power of the cells for the production of a constant biologic effect."

The possibility of the cumulation of the radiation effect was contrasted with the possibility of recovery from the radiation effect. This attitude seemed to nullify the basic idea of any divided dose method of radiation which had for its foundation the cumulation of radiation effects. Because cells may recover from a radiation injury which does not kill them off, it was thought that a divided dose method of irradiation would be of slight effectiveness. Divided dose methods, therefore, came to be regarded somewhat disparagingly. The method of the single session, or at least a concentrated method of treatment, seemed to have been solidly established by the classic work of Seitz and Wintz in 1920, and at the same time to have relegated the divided dose method of Freund to the discard. The victory of the single dose method seemed to be strengthened by a series of other factors. The brevity of the treatment gave it an extraordinary advantage from the standpoint of saving time and material. The fact that roentgen therapy was given in a single session placed it in position to compete with the surgical methods of treating malignant tumors. Only by a single dose method was it possible to fulfill the idea of Perthes of obtaining a definite opinion on the relationships of dose and effect.

But in spite of so many points favoring

the single dose method of irradiation there probably has been no procedure in medicine to which so many objections have been raised as were opposed to the single dose technic. Holzknecht, Schinz, and Regaud, followed by numerous students and collaborators, found themselves at the head of an attack against the single dose method, originating in Germany, and which favored the return to and the re-establishment of the divided dose methods of treatment.

Holzknecht's standpoint is particularly worthy of note, because he was an adherent of the theory of concentrated dosage but not exclusively to single dose methods, probably less from biologic than for economic reasons. Urged on by the failures and the injurious by-effects of the single dose method of treating deep seated malignant tumors, Holzknecht, with his characteristic open-mindedness, began to change his old point of view, and became gradually one of the bitterest opponents of the single dose methods. Due to the activities of the Holzknecht school, it was in Vienna that the divided dose method, originating there, had its Renaissance. Gottwald Schwarz gave it further encouragement and support. On the basis of some previous work of his own which showed the dependence of radiosensitivity on the metabolic activity of tissues, Schwarz developed a new theory to combat the alleged superiority of the single dose methods of radiation. The theory is expressed as follows: "It is possible that within the same structure some cell-groups are more sensitive than others, because of different phases of development or metabolism in which they happen to be. . . . . We have, at present, no possibility of recognizing that moment which is most favorable for irradiating, yet it seems advisable not to irradiate with single massive doses at long-time intervals, which may miss the most favorable period of cell activity, but to employ instead some method of protracted treatment, using relatively small doses daily."

By this was taken the final step in the return to the radiation methods of Freund. And only the fact that this theory was enunciated in May, 1914, and not published until December, 1914, during the World War, has prevented its due recognition, and in the interval the single dose methods were worked out.

After the war Regaud resumed, in the newly established and now so celebrated Radium Institute in Paris, the problem of the optimal method of radiotherapy. To this end he carried out experiments on animal testicular tissues, which tissues, because of a continuous formation of new cells, are very similar to malignant new-growths. The results of this study were reported in 1922. They culminate in the following: "Just as repeated heating at a relatively low temperature at definite intervals is more effective on spore-bearing organisms than single heating at a high temperature, the tissues, because of their rhythm of division and rest of their cells are more sensitive to repeated irradiation with small doses than they are to a single irradiation with a higher dose."

Schinz and Nather continued Regaud's experiments on mouse carcinomas and came to the following conclusions in 1923: "By repeated irradiations at short intervals we can hit by the rays a greater number of dividing cells than we can by a single intensive irradiation. We are forced to the conclusion that a carcinoma can be made to disappear with roentgen rays, if it be damaged at the time of cellular and nuclear division."

The explanation given by Schwarz shows like a red light through all this fog of developing methods, provided that we adopt the conception of cellular division in the place of his idea of metabolic and morphologic changes. This change goes back to a fundamental piece of work by Holthusen, who, in 1921, showed in the case of *Ascaris* eggs that the cells at various stages of development vary in their radiosensitivity, and that they reach their highest degree of radiosensitivity during their mitotic stage.

To what extent it is correct to substitute

for the general conception of metabolic and structural change the specific conception of mitosis cannot be discussed further at this time. But it is an obvious and established fact that the results of Schwarz, Regaud, and Schinz are at variance with the teaching of Kroenig and Friedrich and of Seitz and Wintz. This is the more remarkable because both theories were established on valid experiments, and could be substantiated by suitable clinical experience. Thus there arose a split in roentgen therapy, which all who were roentgenologically active ten years ago can remember vividly, if at times unpleasantly.

Gottwald Schwarz, by his restless and many-sided activities, was in position to adduce evidence in support of both sides of the contention, and was, so to speak, predestined to produce a synthesis of both theories. This actually happened. Starting with the demonstration he himself made that an intensive irradiation is always of greater biologic effectiveness than a divided one, he expressed in 1924 the following thoughts: "*It is possible that the gain* (*Pluseffekt*) *from increasing the intensity is effective in greater degree in tumor tissue than in the skin.*" Schwarz hereby coined the fundamental conception of injury ratios which are the relationships of the radiation damage in tumor tissue to the radiation damage in normal tissue. On the basis of his own investigations he explained his concept in the following words: "I showed in 1914, and Regaud and Lacassagne and Monod showed later, that with regard to increasing sensitivity during mitosis divided doses under certain conditions produce greater injury than a single full dose. The injury to the normal tissues (skin) is in the case of divided doses (and even with high partial doses at short intervals, as I for the first time recently showed) definitely less. In this case the injury quotient is greater from divided doses, or, as one might say, the 'electivity' of the radiation is increased."

To elaborate this new theory of Schwarz the following may be adduced. A radiation concentrated within a short period of time acts on all tissues more intensively than a radiation spread out over a long period of time, and this difference of effect is manifested differently in different tissues. Division of a skin erythema dose into two equal halves given at an interval of twenty-four hours may, for example, produce a markedly less effect in the skin than in a tumor or in some other tissue. If this is the case, then a slight addition of radiant energy can compensate for the decreased effect in and around the tumor, while it is not sufficient to balance-off the decreased effect in the skin. If, as a result of this, the fractionated irradiation has a disadvantage which is not present in the case of concentrated irradiation, namely, that to produce the same biologic effect a greater dose is necessary and a consequent prolongation of the treatment time, then this drawback is counterbalanced by the fact that an equally strong effect in the tumor is produced with less effect in the skin, or by the fact that an equal effect in the skin is accompanied by a greater effect in the tumor.

In this regard there is the analogy of the effectiveness of a heavy and a light filter. With a heavy filter the time of irradiation necessary to produce a skin reaction is longer than it is when a light one is employed. But the equal effect in the skin is associated in the case of the heavy filter with a relatively greater effect in the depths than is the case with the light filter. We say that with the heavy filter the depth quotient is better, just as we say, in the words of Schwarz, that with fractionated irradiation the injury-quotient in tumor tissue is better.

It is to Regaud that credit is due for the experimental demonstration of the correctness of this conception. Regaud treated the testis of the rabbit with roentgen rays. He tried to establish the dose which in a single application would produce permanent sterilization; in other words, a complete destruction of

the spermatogenic epithelium. He found that the smallest dose which could accomplish this end could not be tolerated by the surrounding tissues, but that it produced a severe necrosis of the neighboring skin and the rectal mucous membrane. But if Regaud divided the dose into a period of two weeks then the total dose had to be increased from 4,000 r to 6,000 r, but there then resulted a permanent sterilization, but without skin necrosis.

This emphasizes the point that with fractionated irradiation the radiosensitivity ratio between skin and testicular tissues is changed; that in this case testicular tissue has become more radiosensitive than it was in the case of a single irradiation. We see that with the use of divided doses it is possible to produce complete destruction of the testicular tissues without injuring the skin. With a single dose this effect is possible only at the price of a necrosis of the skin. The effect on the spermatogenic epithelium when the divided dose method is used, has (to again use the words of Schwarz), in fact, become more elective.

Now, if we imagine we are dealing with malignant epithelium rather than with testicular epithelium, the results of these experiments will have a practical significance, for they indicate that a neoplasm which cannot be obliterated by a single dose that will spare normal tissues, by means of fractionated irradiation may be made to disappear without injury to the normal surrounding tissues.

Regaud's researches have not only established the theory of Schwarz of the *dissociated radiation effect* on solid ground, but have also cast much light on the relationships of normal to pathologic tissues, which he suppressed in his theory. For Regaud experimented on normal tissues and found in their case the same contradictions which Schwarz found in the case of tumor and normal tissues. This relationship must be regarded as a special case of a much more general relationship.

This relationship in man can best be studied in the skin, for the skin is the organ which is most often irradiated in a variety of ways. The changes in the skin subsequent to irradiation can be followed in detail, and can even be photographed. The changes in the skin can also be easily followed histologically by the study of suitable biopsy specimens. From these we derive the decisive fact that the skin is composed of a variety of tissues, and that it may serve as perhaps the best object in the study of the differences in reactivity of various tissues to a single and a fractionated method of irradiation. Bearing on this point is the following observation.

A woman received on the left side of the abdomen, including the mons pubis, 800 r, filtered through 0.5 mm. zinc, in a single treatment while the right half of the abdominal wall received two treatments each of 400 r at a twenty-four-hour interval. We can see that whereas the side treated with the single dose reacted with a marked erythema with subsequent pigmentation, the changes on the side given divided doses are very mild. Nevertheless, there is complete epilation on both sides. We also can observe that *hair* and *blood vessels* react quite differently to division of the same dose. Whereas the division of the dose into two days showed no difference of effect in the case of the hair, the division plays a great rôle in the case of the skin blood vessels, for here there is a definitely weaker erythema than where a single dose was given.

Even more instructive are the differences of reaction to single and divided doses if we compare conditions in the *epidermis* and in the *vessels*. If we irradiate in divided doses giving at twenty-four-hour intervals 250 r in eighteen consecutive treatments, a total dose of 4,500 r, there follows a complete disappearance of the epidermis. Regaud has proposed the term "epidermitis" for this effect. I prefer, however, the term "epidermiolysis," because it seems to me to describe the radiation effect—the disappearance of the epidermis—more accurately than

the term "epidermitis," which seems rather to connote an inflammatory reaction.

Epidermiolysis is very impressive when one sees the skin completely denuded of its surface epithelium, exposing the blood-red corium, but this reaction is, as a matter of fact, quite a harmless one if it is produced by divided doses (*Dosi refracta*). The inflammatory reaction subsides rapidly, and in a few weeks new epithelium invades the zone of reaction from the outside, which epithelium is at first almost free of pigment; later on it becomes pigmented to the extent that in the favorable case complete *restitutio ad integrum* takes place, both in an anatomical and a functional sense. The skin which has been the site of an epidermiolytic reaction responds to external agents exactly as does normal unirradiated skin. This is especially important in regard to operative interferences. In my years of experience I have seen many cases in which, after an epidermiolytic reaction, a biopsy or even some important operative procedure was done without the slightest undue reaction of the skin.

Quite different is the course of events in the development of an epidermiolytic reaction which is produced by a single irradiation with a dose which, in my experience, must be of the order of 2,000 to 2,500 r. The course of the reaction in this case differs in many respects from that produced by divided doses.

From a clinical point of view we notice that the epidermis, instead of being depigmented temporarily, seems to be depigmented permanently, and that the lack of pigmentation is of a high degree.

On histologic examination we see that the newly formed epidermis is composed of fewer cellular layers, and that there is a definite tendency toward the formation of anuclear cornified layers. As a result, the epithelium of the skin is thin and markedly atrophic.

These changes in the skin represent the effect of a severe injury which is most marked in the vascular apparatus and which results in poor nutrition of all the cutaneous tissues, so that they are functionally subnormal. This fact is drastically illustrated after any operative procedure. Even the slightest biopsy wound may lead to the formation of an ulcer, which shows only the slightest tendency to heal. If the dose was excessive the ulcer may have an irrepressible tendency to spread. With even higher doses there results a spontaneous necrosis, which involves the whole irradiated field.

In summary, we find that whereas the epidermiolysis following divided doses is harmless and after it the skin returns to normal in a few weeks, an epidermiolysis following a single dose is a definitely severe and dangerous reaction and one which may easily lead to necrosis of all the irradiated tissues. This difference illustrates very impressively the increased electivity effect of divided irradiation. Whereas the single dose shows only a slight difference in the radiosensitivity of the cutaneous epithelium and the vascular endothelium, with divided doses there is made evident a great difference in their radiosensitivity, inasmuch as a complete destruction of the epidermis can be produced without noteworthy injury to the vessels.

In many cases treated for glandular metastasis I have been able to show that a skin which has been subjected to an epidermiolytic reaction from divided doses can still be subjected to 1,000 r more (in four sessions) without any subsequent necrosis.

From a theoretical and practical standpoint it is of interest to determine whether the changes in the radiosensitivity ratio of the tissues after divided doses can be estimated quantitatively. Since there are individual variations in the reaction to both divided and single doses, the question may be settled by studying the reaction to both in one and the same person. I would like to report a few observations bearing on this point.

A patient with a carcinoma of the epipharynx which had been healed by radium received, on account of bilateral metastasis to the cervical nodes, on the

left side 2,000 r in a single dose, and on the right side 4,500 r in eighteen treatments, each of 250 r. The distance on both sides was 35 cm. and the filtration was 0.5 mm. zinc. A severe epidermiolysis appeared on both sides at about the same time, but there resulted a greater injury to the vascular system on the side given the single dose. It was noticeable that the epidermiolysis healed more rapidly on the side which had had divided doses, in spite of the fact that on this side two biopsies were made. The epidermiolysis on the side with the single dose did not heal any more rapidly in spite of the fact that on it no operative procedure was carried out, and the newly formed epidermis remained depigmented for a much longer time.

I wish to cite another case. A woman received (because of lenticular metastasis in the left thoracic wall) a dose of 2,000 r in a single dose, and in the opposite side of the thorax received a total dose of 5,400 r in eighteen sessions, each of 300 r through small fields. The filter was 1 mm. Al, the distance 25 cm. An epidermiolytic reaction was about equal on both sides, and both healed up in about the same time. However, as a result of the excessive dosage in the field which received the single dose there resulted after some insignificant trauma an ulcer which showed slight tendency to heal, while the side which received the divided doses showed not the slightest sign of a tendency to ulceration after a period of observation of one and a half years.

The next case illustrates that after excessive fractionated irradiation more severe reactions may take place than after a single dose. A patient with advanced nodular metastasis after a laryngectomy received on the left side of the neck 2,000 r in a single dose, and on the right side 5,000 r in twenty treatments. The filter was 0.5 mm. zinc and the distance 40 cm. No epidermiolysis resulted on either side, but only a marked desquamation which apparently returned to normal. Now, four years after treatment, there are more telangiectases on the side which received the divided doses.

One can see, therefore, that there are individual variations in the radiosensitivity ratios, but that one is probably correct in assuming that *if one gives not more than 300 r per dose*, or, in other words, gives about a half of that quantity of radiation which used to be called a skin erythema dose, and *if there is an interval of twenty-four hours between treatments*, under the usual conditions of dividing the dose it is possible to give at least two *and generally two and a half times as high a dose as can be given in one treatment.* A dose three and a half times as high under the conditions mentioned, even with divided doses, will probably produce ulceration.

I might add that I have shown that the lethal dose for the epidermis if given in one treatment is 2,000 r, whereas previously it had been assumed that it was about 600 r if given at one time, and resulted in erythema reaction. Since the epidermiolytic reaction after a single dose is about three and two-tenths times as high as an erythema dose, and since with divided doses of 300 r per day and one-day intervals it is possible to give about two and one-half times the epidermiolytic dose, it is possible to give nowadays to each treatment field a dose which is about eight times the dose which had formerly been assumed to be maximal, if given in one treatment. But here we must keep in mind the fact that we are comparing very dissimilar reactions, not the effect of the single and the divided dose, but a simple erythema reaction on the one hand and a complete epidermiolysis on the other. If one considers only the epidermiolytic reaction, then he finds from the observations I have just cited that in the case of divided doses it takes about two and one-half times as high a dose to produce an equal effect in the epidermis without definite changes in the blood vessels and connective tissues.

In the case of the hair follicles and the vessels, considering both single and divided

doses, the injury-ratio is of about the same magnitude. This fact was shown by Gunsett and by Miescher, who have found not in man but in rabbits it is true, that with fractionating at twenty-four-hour intervals a dose two to three times as high is necessary to produce the effect from a single irradiation.

On the other hand, if one knows the injury-ratio one can estimate the intensity of the single dose needed to produce an effect if one knows the intensity with divided doses. In this we assume a half erythema as the single dose, and one day as the interval between treatments. If, for example, a permanent alopecia of the axilla results from twelve treatments each of 300 r, then one may estimate that a dose of 1,500 r given in one session will produce a permanent alopecia, and that this dose will be constantly followed by telangiectasis but probably not by ulceration. This is a further demonstration that after a single irradiation the effect on the vessels is not so great as after divided doses, but that the effect on the hair follicles is less compromised.

Now the question arises, What tissues act toward divided doses in the same way as did the testicular tissues in Regaud's experiments or the epidermis and the hair follicles in my own observations? Radio-biologic experience has shown that to this category belong the ovarian follicles, the lympho- and hematopoietic tissues, and the sebaceous glands.

What factor is common to all these tissues? They are not, according to the definition of a tissue, made up of one and the same tissue or a single variety of cells, but are made up of different cellular layers anatomically different, and differing in spatial arrangement, and of these tissues the skin is a good example. By their composition from different types of cells these tissues resemble the structure of an organ, or they are, so to speak, of organoid structure. But the individual kinds of cells are not only functionally interdependent as is the case with an organ, but are also genetically interdependent, for one kind of cells produces the others. We designate this kind of cell the *mother cell*. To this group belong the basal cells of the epidermis, the hair follicle, and the sebaceous glands, the spermatogonia, the primary ovarian follicles and the lympho- and the erythroblasts. By progressive transformations and successive stages of greater differentiation these cells finally result in the formation of structures that are either anuclear, such as the horn cells and erythrocytes, or lose their function of mitosis, such as spermatozoa or lymphocytes. All these cells are incapable of independent life and are destined to destruction. In these tissues we can differentiate at least two types of cells: (*a*) the cells which constantly are in the process of transformation—the *mother* or *germ* cells—and (*b*) the cells which are no longer capable of living, the *end* or *functioning* cells. In most cases these tissues contain another type, (*c*), a layer of *intermediate* cells.

Considering their general nomenclature, I would like to propose the term "multiform tissues," because this term best designates their true properties, since they are made up of many different kinds of cells.

The contrast with the simple *uniform* tissues. These tissues, as the term indicates, consist of one kind of cells, which are generally arranged in one layer, and which exercise some different and specific function. They have no power of regeneration, so that their obliteration is definite, once they are destroyed. The fact must be kept in mind that their destruction produces no physiologic sequelæ. As a rule their death takes place accidentally, usually through the mechanism of damage to vessels which supply them, of which atherosclerotic gangrene, cerebral malacia, or pulmonary infarction are classic examples.

To the group of uniform tissues belong all single-layered epithelial tissues, the endothelial layers of the vessels, and the serous membranes, the cylindrical epithelium of the mucous membranes, as

well as exocrine and endocrine glands. To this group belong, further, the spindle-celled connective tissue elements, and all tissues derived from connective tissue, bone and cartilage, muscular and nervous tissue.

MULTIFORM TISSUES
Ovarian follicle
Spermatogenic testicular epithelium
Lymphopoietic system
Hematopoietic system
Hair follicle
Sebaceous glands
Epidermis
Basal epithelium

UNIFORM TISSUES
Endothelium of the vessels
Endothelium of the serous membranes
Spindle-celled connective tissue elements
Fixed connective tissue and glia
Osseous and cartilaginous tissue
Muscle tissue
Nerve tissue
Cylindric epithelium

The difference between the two types of tissues does not agree, as can be seen in the foregoing table, with the difference between epithelial and mesenchymal tissues, nor with the difference in their origin from various germ layers.

The differences in the two types of tissue lie not only in their anatomic structure but also in their reactions to *radiation*. The *multiform* tissues as exemplified by the spermatogenic epithelium of the testis or the epidermis *are more radiosensitive than the vessels* and can be electively destroyed, therefore, by radiation. The destroyed cells are resorbed. This process either proceeds without any reaction, as is the case with lymphatic cells or germ cells, or it gives rise at most to only transitory inflammatory phenomena, such as can be observed in the basal cells of the skin and mucous membranes.

On the contrary, the *uniform tissues* as exemplified by the sweat glands or the spindle-cell connective tissue elements *are less radiosensitive than the vessels*. They cannot be made to disappear primarily (*electively*) but only secondarily (*nutritively*) and indirectly through injury to the vascular endothelium, with secondary endarteritis. As a result of this process the dead cells are sloughed, with the ensuing clinical picture of a sequestration or gangrene of the irradiated tissues.

The pictures of a roentgen-epilated skin, on the one hand, and an ulcerated skin, on the other, emphasize the different radiosensitivity of the two types of tissues, and the different mechanism of their destruction which depends on it.

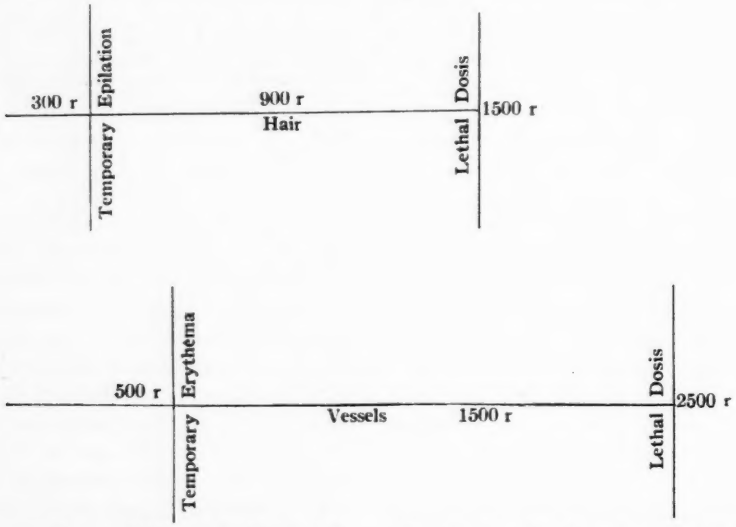
The low radiosensitivity which is associated with the permanency of the uniform tissues is of great radiologic importance, because of their vital function and because they are irreplaceable anatomically, and therefore the conception of a therapeutic dose means that quantity of roentgen rays which produces no necrosis in the vessels or in the uniform tissues. Higher quantities of radiation which produce necrosis of the uniform tissues have, as such, no place in radiotherapy. They are to be regarded not as radio-physiological, but rather as radio-pathologic.

Radiotherapy, therefore, has a particular interest in sparing these tissues.

It seems to be a fact of the greatest importance that divided dose technics are the best way to accomplish this end. It is evident that *the multiform and the uniform tissues do not react in the same way to single and divided doses. Fractionating results in a less decrease of effect in the polyform tissues than in the uniform tissues.* Regaud showed this in the case of spermatogenic testicular epithelium. I have referred to my own observations on the behavior of the epidermis and the hair, and have referred to analogous experiments of Miescher and Gunsett on the hair follicles. We could bring in analogous data on the other polyform tissues, but let it suffice for the present to point out the professional injuries sustained by radiologists. Injury of the hematopoietic and the lymphopoietic systems and the genital glands resulted from the summation of very small doses, without any recognizable injury of the skin or pathologic changes in other tissues. Fractionating, therefore, exerts a much stronger effect on

the multiform than on the uniform tissues. Expressing this in the words of Schwarz, the injury-ratio with divided doses increases in the case of the multiform tissues and decreases in the uniform. In other words, the difference in radiosensitivity between the multiform and the uniform tissues increases with fractionated irradiation, whereas the multiform tissues seem more radiosensitive to divided irradiation than to single dose irradiation.

Now the question comes up, What is the cause of this fact that multiform tissues act differently to divided and to single doses than do the uniform tissues? This may be due, in the final analysis, to the fact that multiform tissues have a higher radiosensitivity than the uniform tissues. This fact means only that in the case of the multiform tissues a physically smaller dose is sufficient to damage them lethally, whereas to attain a biologically equivalent effect on the uniform tissues a much greater physical dose must be employed; therefore, to produce a biologically equivalent partial-effect a smaller dose is needed in the multiform tissues than in the uniform. For the same reason equal fractions of a dose will produce in the radiosensitive multiform tissues more intense partial-effects than in the less radiosensitive uniform tissues. A biologically more intense partial-effect will either last longer, or return to normal more slowly. It will necessarily cumulate subsequent partial doses better than a weaker one which produces a more transitory effect which rapidly returns to normal.



Let us now look at a concrete example of these relationships (see diagram). Experience has shown that to produce an irreversible damage to the hair, a permanent alopecia, a dose of about 1,500 r, given in one treatment, is necessary. To produce a biologically equivalent effect in the vessels, that is, to produce an irreversible injury which will lead to an ulceration, a dose, if given at one time, of about 2,500 r is necessary. We can assume, therefore, that to produce a biologically equivalent partial-effect on the hair follicle a physically smaller dose, about 300 r, will be necessary; on the vessels, on the contrary, a larger dose, about 500 r. Clinically the former results in a transitory epilation, the latter in a transitory erythema. After a certain time both changes will give place to normal conditions. Now if both tissues receive the same dose, for example, 300 r, there will be a more marked effect produced in the hair follicles than in the vessels. For 300 r means more in the case of the follicles than in the vessels, because 300 r is one-fifth the lethal dose for the hair follicle, and

only one-eighth the lethal dose for the vascular endothelium. A dose of 300 r will probably produce a temporary epilation but probably no demonstrable erythema. The stronger effect in the hair follicles will naturally be more difficultly reversible, and therefore last longer than the weaker, more easily reversible, and briefer effect on the vessels. If, after an interval, we apply 300 r again, then the biologic effect of the first irradiation will be still evident in the case of the hair follicles, or may even be emphasized, whereas in the vessels the reaction will have subsided or will be intensified only a little. As a result of this the second partial-dose will injure the hair follicle more than it will the vessels; or, from another point of view, dividing the dose spares the vessels more than the hair follicles.

The fact that divided dosage is relatively more effective on the multiform than on the uniform tissues depends also on the different capabilities for cumulation of these two tissues, which fact is based on the different radiosensitivity of the two types of tissue. In general we can say that the higher the radiosensitivity the smaller are the doses which can cumulate, the less radiosensitive a tissue, the less its capability for cumulation, and the greater must the doses be for the production of biologically equivalent partial-effects.

So far, we have compared the relationships of normal tissues to each other. In regard to tumors, I wish to point to the theory which I have developed, according to which tumors do not behave fundamentally differently toward radiation than do the mother cells from which they are derived. I have given evidence for this point of view elsewhere (1932). With reference to this question I would like to repeat it again and add that radiobiologic experience and the literature, both, add new substantiation of the correctness of this conception. We can sketch it briefly as follows: it happens that in some tumors there are a great number of elements that are more radiosensitive than their mother cells and, therefore, can be made to disappear without injuring them. Other tumors contain a varyingly great number of elements, the radiosensitivity of which is the same order as that of the mother cells, and, therefore, they cannot be made to disappear without destruction of the mother cells.

Therefore, we may differentiate two types of tumors. To the first belong those tumors which are made up of polyform tissues. We can classify them as *constitutionally radiosensitive*, because they are made up of tissues which can be made to disappear completely without injury to the vessels. To the second type belong those tumors which are derived from uniform tissues. We may classify them as *constitutionally radioresistant*, because they may be made to disappear only at the price of a vascular necrosis, or else they may be made to decrease in size to an indefinite extent.

Lymphosarcomas, seminomas, granulosa-cell tumors, tricho-epitheliomas, and the basal-cell carcinomas of the skin and mucous membranes are in the group of constitutionally radiosensitive tumors. Adenocarcinomas, most sarcomas, and most gliomas belong to the group of the constitutionally radioresistant tumors.

In the case of the constitutionally radiosensitive tumors it is possible to continue divided treatments to the point of the desired radiation effect, that is, up to the point of disappearance of the tumor. But in the case of the constitutionally radioresistant tumors only a formal fractionation is possible because there is no normal to base the height of the total dose on or the degree to which the dose should be fractionated; the goal of irradiation, the disappearance of the tumor after irradiation, is not possible to achieve with radiotherapeutic methods. It is in this group of constitutionally radioresistant tumors that divided doses manifest their greatest value. For there is in this group of tumors a more or less large number of elements which are of a greater radiosensitivity than their mother cells, and on which fractionation is the more effective the more radiosensitive the tissue is, and, therefore,

fractionation may be more or less effective in the constitutionally radioresistant tumors, depending on the proportion of radiosensitive elements they contain. The fundamental make-up of a tumor of necessity sets the limit to the increase of electivity of the radiation effect possible by dividing the dose. It is evident that fractionation is no radiotherapeutic panacea. The radiobiologic activity of a tissue, and the tumors derived from it, determine the effectiveness of any radiation technic by which it is treated.

These are the basic facts of divided dose treatment, as first established by Freund, theoretically explained by Schwarz, experimentally certified by Regaud, and worked out practically by Coutard.

Now the Coutard method, regarded from a historic point of view, is nothing more than the method of Freund adopted to special aspects of particular tumors, and a modernization of his ideas as a result of the accumulation of experience and experimentation in the intervening years. *The fundamental theory, the continuation of small doses up to the point of the onset of the desired effect, remains unchanged.*

We see from all this that it is not right to designate the divided dose method as one of weak irradiation in contrast to methods of intensive irradiation, for in the case of fractionated irradiation only the individual doses are small and weak; the total dose may be very high, in fact, much higher than those of the so-called intensive methods. We must keep in mind that low and intensive doses are only relative terms, and that the very same dose from the standpoint of a carcinoma may be regarded as very small and from the standpoint of an inflammation, very high. One cannot say, therefore, that in the case of divided dose treatment no severe tissue reactions take place, for it is generally known that with the Coutard technic very definite reactions are produced, such as were previously unknown, or, at least, were not common. Nor is it correct to regard the divided dose method as a poor way to carry out treatment now that dosimeters are available for measuring the effect of treatment. As a matter of fact, Holzknecht had a dosimeter in 1902. We know that since accurate dosimeters are universally available we can measure the dose necessary to produce any effect, and it is no longer necessary to continue irradiation with small doses up to the point of the onset of the desired effect, as was necessary before there were dosimeters available. In these days it is clear that the question whether the individual dose can be measured or not has nothing to do with the biologic foundation of divided dosage, because it is possible when a divided dose technic is used to measure the individual doses very accurately, such as, for example, with the Mekapion of Strauss.

It is beside the question whether we designate the fractionated method as the original and contrast it with expeditive methods of irradiation. We know that we can irradiate with divided doses; in other words proceed expeditively, as is so often the case nowadays, but still even if we do not irradiate in a single session we are constrained to limit the irradiation to a definitely spaced serial treatment.

It is correct, nevertheless, to regard fractionating as the original method of radiologic treatment, for it was, and still is, the fundamental method in radiotherapeutic procedures. As a result of this, radiotherapy has become one of the most important methods of treatment in the whole field of medicine, due to the inspiration of Freund, forty years ago.

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TISSUE NECROSIS

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WITH the advent of new ideas and discoveries older theories gradually need revision as they become inadequate. Any departure from previous concepts should not be proffered in a spirit of dogmatism and should be most critically considered before being incorporated into even a working hypothesis. It is with this attitude that I wish to present a number of, what I think to be, concepts which differ in part from existing ideas in the study of underlying events in the production of necrosis in the living organism. There are so many phases of this problem that it will be impossible in such an abbreviated treatise to cover many of the controversial points, and again no single individual can be so imbued with knowledge as to adequately explain all the different phenomena in proper terms of chemistry, biology, physiology, and experimental and clinical data. It will be necessary, therefore, in great measure to depend on facts and opinions already presented by others. A number of dogmatic ideas must necessarily be presented without the proof of personal experiment, especially as it would require methods which will still have to be developed. Opinions here presented are the result of long consideration of what were thought to be better explanations of events, arrived at from copious laboratory, pathological, roentgenological, and clinical observations. Roentgenological findings, perhaps, offer much more important contributions in pathological diagnosis than is ordinarily thought, as changing events can often be much more conveniently followed roentgenographically than in the pathological laboratory.

I doubt that any two pathologists would quite agree on what really constitutes "tissue necrosis," even though the description of the gross and microscopic events of necrosis might be adequately described.

In the consideration of this subject the vast field of immunity must necessarily enter. Antibodies, opsonines, agglutinins, inflammatory reactions, allergy and all that it implies, all contribute to the process we wish to describe.

In the discussion of tissue necrosis it is not my intention to describe the slow replacements such as we see in liver cirrhosis, secondary contracted kidney, etc., where the real functioning elements gradually degenerate and disappear under the influence of long-standing insults of numerous sorts. An entire organism or individual organs may suddenly cease to function, but such events do not constitute necrosis. Caustics may quickly destroy tissue as do other agents like extreme heat, chemicals, electricity, radiation, etc., but we shall not consider such in this paper. Neither shall this paper be concerned with the results of low-grade inflammatory reactions, where tissue destruction is a slow process varying in each case with variable and slowly changing conditions.

We shall begin by considering acute inflammatory processes. First, we have our irritant which may be one of many kinds: we prefer for simplicity to assume a bacterial irritant. The response varies according to the type of invading organism and the reactivity of the host, both of which may show great variation. The cellular response is a very important factor and again varies with the host and the invading organism. However, it is my belief that too much emphasis is placed on segregating different infections according to the offending organism, although we must recognize that the course of events must necessarily depend upon the nature of the invader. Nevertheless, infections all have a certain similarity regardless of such differences, and the general consideration of infection leads often to a better understanding of what is taking place.

In the study of inflammatory processes

one cannot escape the necessity of studying capillary activity in normal tissue and under various abnormal conditions, especially in case one is considering the early phases of inflammation. Krogh (1) has furnished us with rather elaborate descriptions of such investigations, and has demonstrated intrinsic contractility in the ultimate cells of capillaries, the so-called Rouget cells. Clark (2) seems to differ on the separate contractility of such cells, unless they have already received their nerve supply. The nervous mechanism has been traced to both sympathetic and para-sympathetic nerve supply (3), the sympathetic being chiefly concerned in contractility while the para-sympathetic nerve supply is principally involved in dilatation, although the action may be mixed. Reflex phenomena through other nervous paths are unquestioned and are most important in the consideration of our problems. Psychic and emotional influences may involuntarily influence the mechanism of our vascular system. Cannon (4) has demonstrated the relationship between the mid-brain and many of our reflex phenomena, and the close relationship of many autonomic nervous activities with our higher nerve centers. He prefers to link up many of these activities with the adrenal and other glandular secretions. The close inter-linking of various divisions of the autonomic nervous system must not be lost sight of. For example, many of our gastro-intestinal symptoms associated with gall-bladder disease cannot be explained on the basis of anything but overflow nerve impulses or reflex influences. In other words, we all know a local reaction may be the result of a distant stimulus and may be quite intense.

The nature of the local reaction may be intense or mild, and quite a few factors are responsible, as stated above. In the final analysis the reactivity of the individual is a most important consideration. The reactivity depends on a number of things, some of which may vary in individual cases or under different influences. An individual suffering from one ailment may respond more intensely or less intensely to a superimposed infection. An infection may confer immunity to a greater or lesser degree for any subsequent reinfection. Then again, an infection may cause a most intense reaction about any reinfection, and is said, therefore, to produce a hypersensitivity. The literature has been flooded with attempts to explain the nature of this so-called "allergy" (5). Tuberculous infection probably offers us our best example of variation in infectious allergy. Eczema, urticaria, angioneurotic edema, pollen sensitivity, infectious allergy, and food allergy are all fundamentally similar. There are quite a number of other conditions which also come under the caption of allergy. When one tries to analyze the similarities in these conditions one feature stands out—the interference with the normal circulation of the part said to be allergic. Just to what degree the lymphatics, which are primarily afferent vessels, participate, is not entirely clear, but the capillary blood supply is probably the main source of our tissue reaction. While it is possible that a direct chemical influence on the capillary walls may be partly responsible, there is much evidence that the nervous mechanism in control of the vascular supply is perhaps more essential in the production of such exudates. Hypersensitivity is at least partly and perhaps entirely a result of a sensitized autonomic nervous system. Stimulation of the sympathetics may result in blanching of the part or in marked congestion. The mechanism of so-called "sensitization" still remains unsolved. More and more conditions are being considered under the subject of allergy and it becomes apparent that a large number of reactions cannot be explained on the basis of a sensitizing substance which develops and perfuses the entire body. Some of the conditions we shall describe can have nothing but a nerve connection between the exciting cause and the ultimate effect. Whether one can still explain local tissue swellings (6) on the basis of a local production of a histamine-like substance (Lewis' H-substance) and its effect on the local

capillary wall, offers much room for argument. Most tissue swellings seem to show a direct relationship between the filtration pressure of capillaries and the osmotic pressure of the capillary blood, which depends, for the most part, upon the nonfilterable colloids (1).

It is more than probable that even in a tuberculous reaction following reinfection the allergic manifestation is predominantly a fluid exudative reaction with the cellular elements responding merely as an infection response, which is determined by the nature of the infecting organism and the infection products. Our really destructive processes are invariably localized to individual areas, which may possibly become confluent although this is of no moment.

Whether necrosis occurs in an internal organ, as in tuberculous cavitation, lung abscess, etc., or in deeper layers of the skin, the reaction is essentially the same. The body attempts to throw off the infection in various ways, always proceeding in the direction of least resistance. A deep infection may eventually produce a long draining sinus; a lung infection which produces an intense reaction may produce a cavity draining eventually through a bronchus, while a deep skin infection (like a boil) likewise throws off infection by discharging the entire products of the reaction plus the offending organism. The animal body has adopted this method of removal of infection as perhaps the most economical method in most cases, although it proves very dangerous when used in the internal organs; they are not so often infected when compared with the innumerable cases of skin infection. If one observes a boil develop from onset, one first sees the stage of congestion. During the congestion (red) stage there surely is no tissue destruction, as such stages often subside quickly with no evidence of the infection remaining. One then gradually approaches the stage of central discoloration and blanching which indicates that the blood supply has been entirely choked off from the immediate site of infection. An anoxemia has resulted and tissue asphyxiation has begun. It is my contention that rapid tissue necrosis cannot occur where an adequate or even partially adequate blood supply is present. Again, lung abscess, tuberculous cavitation and other abscesses are always the result of asphyxia with subsequent cell death. Infarcts show necrosis according to the degree of collateral circulation still present. Whether we have caseation or immediate liquefaction of the infected area before the necrotic elements are cast off depends upon complicated processes which have aroused much interest and speculation.

One inquires about the reaction necessary to bring about asphyxiation. It is my belief that one cannot develop an abscess unless pressure from the reaction of the site of the abscess is sufficiently high to close off the arterial blood supply to the part and produce an anoxemia. It is a known fact that pressures short of the local systolic arterial pressure will not prevent blood from entering the capillary bed of the part, although capillaries may of their own accord contract to blanch a portion of the capillary bed. Terminal arterioles may constrict to diminish the amount of blood flowing to any area. Normally capillaries may not be fully open or some may be temporarily closed, according to the tissue demands and the amount of blood circulating through the part. Certain groups of capillaries may collapse or close if the remainder of the capillaries dilate to accommodate the blood flow, but nothing short of the systolic arterial pressure of the supplying artery can stop the entire circulation of the part. Such pressures cannot develop where there are no limiting membranes. Non-encapsulated empyemas, peritonitis, mediastinal abscess, retroperitoneal abscess, etc., as such, never lead to tissue necrosis. A limiting membrane is essential. We find such a membrane in the surrounding fibrous capsule of our primary and secondary lung lobules. An appendix cannot become abscessed unless the lumen becomes blocked. Fibrous tissue has an enormous capacity for expansion, but only when the expansion can take place slowly. The areolar tissue of our skin contains in-

numberable closed fibrous-walled cells. Every other organ contains fibrous divisions and septa which are not quickly expansile. It is questionable whether the brain requires quite the same congestion pressure to produce necrosis, although we do have sufficiently tough septa to prevent undue spread of the pressure effects from infection in brain abscess. In osteomyelitis, infection passing into the marrow by way of the nutrient foramen quickly involves the bone marrow, and the spread of pressure effects results in asphyxia when the intra-medullary pressure equals the systolic pressure of the nutrient artery. Bone lymphatics in such conditions as Garrè's disease may become chronically infected without the violent reactions one finds in osteomyelitis. Syphilis and other diseases may act similarly. In young children in whom the marrow cavity is smaller and the epiphyseal arteries are of greater importance, these arteries are more often the source of bone infection. In these cases the infection may not reach the marrow cavity and only localized bone abscesses may result, which may discharge externally without reaching the marrow. If the marrow becomes thoroughly invaded by infection and reaction, the entire diaphysis must necessarily become necrotic, unless the pressure has been relieved surgically or by discharge of the pus, before sufficient time has elapsed to thoroughly asphyxiate the bone cells. We are quite certain that early diagnosis of osteomyelitis, and surgical relief of developing intramedullary pressure, will limit the amount of bone destruction, in spite of the danger some believe to be present from dissemination of infection in too early surgery. We all know that compound fractures generally do not result in osteomyelitis, unless the marrow cavity closes through callus formation, which now produces conditions suitable for increased intramedullary pressure. There is a great difference between osteomyelitis and bone infection, although the resulting bone necrosis follows a somewhat similar course.

It is my belief that, regardless of what the x-ray will show in the way of bone absorption in osteomyelitis, any subsequent evidence of more bone destruction is merely the manifestation of tissue damage resulting from the inflammatory reaction at its height. In other words, bone killed but not absorbed, or bone damage beyond repair, will subsequently absorb to produce the impression of advancing infection. Likewise it is my contention that tuberculous cavitation may show cavities of increasing size, but that the cavities are again predetermined in size by the degree of tissue reaction and local pressure effects, at the height of our so-called allergic reaction. The peeling off and absorption of material from the wall of the tuberculous cavity again is confined almost entirely to tissue damage by the initial reaction. Thrombosis of wall vessels with resulting vascular insufficiency may possibly add a little to the process. Closure of the outlet of a cavity might mechanically stretch and enlarge an existing cavity through pressure from exudates accumulating within the cavity. The tendency is, of course, to cavity shrinkage, through scar retraction, and, as some believe, to outlet closure with subsequent absorption of the contained air causing cavity collapse. New cavitations are not extensions but new infection implantations on virgin tissue with extreme sensitivity and good vascularity and, therefore, intense reactions. Reactivation of old lesions is rarely so intense. Large cavitations almost invariably occur with highly allergic reactions, and one may anticipate these cavities by picking out the most dense, most highly exudative areas in our x-ray films. The degree of allergy present is not always apparent in our lung plate as a subsiding lesion with very little exudate may be accompanied by an increasing hypersensitivity which might prove really dangerous only if new implantation occurs. The Mantoux skin test should be of prognostic significance and a guide to treatment. As allergy subsides with time, so would the danger from cavitation subside until reinfection restimulated the patient's hypersensitivity. I am certain that with

identical doses of tuberculous infection from primary infection, different individuals would produce different degrees of sensitivity and, therefore, different tuberculosis pictures. This may explain the so-called degrees of immunity in different races or families, which is still, however, a controversial subject. I am of the opinion that allergy is perhaps our most important factor in prognosis (7). Except in widely disseminated tuberculosis, like miliary tuberculosis, meningitis, etc., the most severe cases of pulmonary tuberculosis result from spread during the heightened stages of sensitivity. Just as we have familial tendencies to asthma so do we have great variations in intensity in the response to tuberculous infection, which must depend in great measure on the individual's allergic response to such infection and reinfection.

Those who wish to dispute the above might wish to point to the clinical symptoms one encounters in tuberculosis. As far as the toxic effects of the tubercle bacillus, this is negligible as shown in the mild nature of the reaction in our primary lesion. It is also a very slowly developing organism and, therefore, we cannot attribute many of the symptoms to its digestion products. It is only after the patient has developed tuberculous sensitivity (one to three weeks) (8) that the tuberculous infection, or reinfection, produces toxic symptoms, and these must be ascribed, therefore, to the sensitivity reaction. Just what the source of the toxic symptoms is, one can only surmise, as we have several possibilities to consider. Bacterial ferment activity probably is more important when considering toxemia produced by other organisms, but not so much when considering tuberculosis. (Secondary invaders are not considered factors.) Asphyxiation with tissue death may result in the liberation of ferment (mostly proteolytic) from the destroyed cells. The white blood cells, especially the polymorphonuclear neutrophils, are normally short-lived and liberate much enzyme when destroyed. Digestion of damaged cell tissue probably produces products of digestion which are toxic. We have normal enzymes which are incapable of digesting normal tissue but damaged tissue may be easily digested with resulting toxic symptoms. Antihormones which exert restraining influences on internal secretions, it would seem, are more easily destroyed than hormones and enzymes. Can cell death be explained on the basis that loss of certain restraining influences, possibly through lack of oxygen or some other agent, allows digestive fluids to attack our now unprotected tissue? Electrolytic changes, chemotactic influences depression of normal cellular enzymatic activity, nuclear alterations, disturbance, of normal permeability of cellular membranes, precipitation of colloid cellular elements, etc., have all been described as causes for cell death and autolysis. A number of years ago Jöbling (9) described a long series of experiments in which he showed that gummas were absorbed through normal body ferment activity after iodide therapy, because of the action of iodine in producing saturated fatty acid compounds out of unsaturated fatty acid compounds in the gumma, thereby allowing normal body ferments to digest the gumma. Such events are interesting in our consideration of cellular digestion. Harmless substances may produce highly toxic digestion products through the action of bacterial ferment. It is my belief that when we speak of these as toxic products we mean chiefly their effects on the centers of the central nervous system rather than their immediate effect on the local tissue, which must be comparatively little. The local necrosis is the result of asphyxia, and whatever goes with the anoxemic state. As the pressure within the inflammatory area becomes lessened either through a discharge of the necrotic material, or through subsidence of the reaction and absorption of material, symptoms quickly subside. A positive pressure in the reaction area is essential for toxin absorption and toxic symptoms. A knife plunged into a boil reduces the pressure sufficiently to relieve most symptoms almost immediately. Absorption into the surrounding lymphatics

and capillaries of toxic products depends to a great extent on this driving pressure.

Most tissue reactions, even in the highly allergic, are self-limited, with the time limit varying with each type of infection and its intensity and complicating factors. The development of pressure equal to or greater than arterial pressure should necessitate some speculation regarding its production. The permeability of damaged capillaries has been frequently described. Other factors, however, probably enter to help the production of these exudates. Electrolytic changes with acidulation of tissue from oxygen lack probably have much to do with the increased vascular permeability, through capillary damage. Whether or not these changes, which must necessarily produce only slight increases in the *p*H of the tissue, result in the greater fixation of fluid in those tissues through accumulation of electrolytic metabolites would be difficult to prove. Martin Fischer (10), by demonstrating the increased water-absorbing power of either acidulated or alkalinized gelatin, was convinced that edema was merely a matter of tissue *p*H. Osmosis and diffusion depend greatly, however, on other factors. There is probably a combination of factors entering into the production of extreme pressure exudates, which only time can explain adequately.

Again, we know that in closed bony cavities, sinuses, and long bones, we may produce marked necrosis of bone without much possibility of fluid entering from any source after the local blood supply is blocked. It has been shown by Brooks (11) that in osteomyelitis the intra-medullary pressure must be equal to the arterial systolic pressure before osteomyelitis can develop. It has long been my contention that dental apical abscesses, as seen in x-ray films, are the result of asphyxiation necrosis. At the height of these reactions the x-ray may show nothing except possibly evidence of a thickened pericemental membrane from congestion. The ragged radiolucent shadow ordinarily called the abscess is merely due to the absorption of bone damaged beyond repair by pressure effects at the height of the reaction. This absorption takes place in the same way that any other dead bone would be absorbed, through osteolytic ferment activity (12). We do not find these periapical absorption areas where the conditions do not allow the local accumulation of reaction products and pressure effects. If the dental root canal allows sufficient drainage to prevent local pressure effects, we do not see bone absorption. When the dental canal is closed in such cases by dentistry or otherwise, an intense reaction may follow, with marked swelling of the face, indicating that the infection has perforated the alveolar plate. Even now the radiograph may show very little of the usual evidence of periapical bone absorption at any stage of the infection, because of the drainage of inflammatory products into soft tissue. It should be apparent that here also, pressure effects must account for bone necrosis.

I wish briefly to discuss my concept of gastro-intestinal ulceration. As stated above, the effects produced in tissue destruction are the result of asphyxiation, and the autonomic nervous mechanism (so-called sympathetic and para-sympathetic nervous system) is probably the underlying factor in producing the vascular response that produces the asphyxia. It would be well to mention that it takes an irritant like bacterial infection to produce many of the results of tissue necrosis such as we see in abscess formation. Somewhat different factors are found in sterile asphyxiation of tissue, as I believe most of our peptic ulcers to be in the early stages. While it is true that we may have ulceration, produced by gastric syphilis and a number of other conditions, where the process is gradual, with slowly produced vascular insufficiency which may result in local tissue death, such processes, I do not believe, are the ones followed in our ordinary gastric and duodenal ulcers. When one considers the total lack of proof one cannot but consider this as anything more than a rather bold assertion of what may look like facts. After seeing a number of allergic individuals who, following

ingestion of certain food-stuffs which "always cause distress," present the symptoms of acute gastric ulcer and, in some cases, definite x-ray ulcer findings, and in others what is commonly termed "duodenitis," one cannot dismiss the possibility of food allergy being the causative agent in the production of many peptic ulcers. Sensitization to infection, pollens, or chemicals could also be a factor in some ulcers. I personally prefer to view certain phenomena that may accompany gastric and duodenal ulcers of rather diagnostic significance. It has been my experience that a fairly high proportion of such ulcers are accompanied by markedly thickened gastric rugæ, and this has generally been termed an accompanying gastritis, thought to be produced by ulcer irritation of the entire stomach with resulting pylorospasm, hyperacidity, and congestion. More recently I have been of the opinion that the congested thickened gastric rugæ could better be explained as an allergic manifestation, of greater or lesser duration and acuteness, and of which the ulcer may be a more outspoken manifestation. With this in mind it is more than probable that neither bleeding, hyperacidity, pain, spasm, or increased peristalsis need constitute the really acute phase of an ulcer, but that the accompanying allergic reaction (swelling and injection) constitutes the background for acute activity and reactivation of ulcer areas. These ulcers would be the result of the anoxemia of the tissue from pressure effects, perhaps aggravated by trauma. Pain and variations in gastroduodenal activity are exaggerated during the hypersensitivity reaction. One might assume that healing would be promoted by avoiding anything that might induce a local allergic state. So-called "tension ulcers" have been variously described recently. Nerve strain, tension, worry, have been forerunners of many ulcers, usually duodenal, and mental relaxation seemed to result in prompt cure or at least improvement in most of such cases. It may be assumed that the sympathetic vascular nerve endings are reflexly stimulated through the higher nerve centers, to produce our histamine-like substance (Lewis' H-substance). I should personally prefer to avoid the use of any intermediary H-substance in order to explain such phenomena. Considering all things, it would seem that the local histamine-like substance would need to be the same in different forms of allergy, but with the necessity of the sympathetic nervous mechanism becoming sensitized to each allergen in turn. The H-substance would be produced only when the nervous mechanism stimulated its production, and probably does so only during the allergic reaction, and is perhaps limited to the area of allergic manifestation. Higher nerve centers, as shown above, have a marked influence on the autonomic mechanism, and *vice versa*. It is conceivable that irritation of the gastro-intestinal nervous mechanism at any point may ultimately result in ulcer formation at some other point through the same allergic process. The frequent association of a duodenal ulcer with a so-called chronic appendix may be so explained, or are we dealing with an appendix also in a allergic state? Rowe (5) has called attention to appendices which are swollen and injected and are definitely in an acute allergic state. There are those who claim that the pendulum has swung too far in our classification of allergic states, and perhaps this article would appear to exaggerate the condition. Much depends upon one's viewpoint in explaining such events.

Certain individuals frequently present a museum of allergic manifestations. One particular case I recall presented almost every variety of allergic manifestation, although, fortunately, only one allergic condition presented itself at any one time. Amongst the symptoms were "vacuum sinus" headache, some polypoid and nasal sinus membrane swelling, hay-fever, urticaria, eczema, asthma (very severe at times), and abdominal distress, originating mostly in the gall bladder and proximal colon areas. During one of these abdominal attacks the entire colon and especially

the proximal colon, when seen under the fluoroscope after a barium meal, presented a lumen reduced to the size of a knitting needle, and the colon was hard and ropey to the touch. Subsequent x-ray examination did not show the extreme colon spasm. The gall bladder was normal. Such findings are not unusual, and under such circumstances must be considered as hypersensitivity reactions. We should proceed with caution in discarding the time-honored explanations of events in gastric and duodenal ulcer formation, but I see no reason why many of the so-called causes cannot be more easily explained as the results of ulceration. Our ideas are changing also in other directions. So-called acute glomerulonephritis is held by many to be a manifestation of kidney sensitization (vascular sympathetics). A recent case that I had the opportunity to follow proved most interesting. Sensitization of the kidney parenchyma (other organs probably also became sensitized although this was not so apparent) occurred following measles, although there was nothing to indicate this at the time. An acute mastoiditis developed at a later date, whereupon the patient became edematous, pale, and poured out much urinary albumin. Because of the patient's bad condition x-ray mastoid therapy was advocated. A temporary clearing of the mastoid, following good drainage and clearing as seen by x-ray examination, resulted in almost complete remission of all the symptoms and urinary findings. After a week, with subsiding discharge, closure of the outlet in the eardrum resulted in a recurring mastoiditis and immediate recurrence of all the nephritic findings. Drainage was soon re-established, with again, prompt disappearance of symptoms and urinary albumin. This all occurred within a period of three weeks. It is not the rule for so-called acute nephritis to develop with mastoiditis, and sensitization appeared to be a preliminary essential for its production here. Tenosynovitis, bursitis, arthritis, and other conditions during acute exacerbation stages can often be best explained on an allergic basis.

DISCUSSION

After perusing the above, certain points stand out as needing further discussion. Assuming that anoxemia is our primary cause of cell death, it becomes a rather difficult matter to prove the events which actually take place in its production. Thrombosis of blood vessels is always present in abscess, but should it be considered a late result of necrosis or the cause of asphyxiation necrosis? Osteomyelitis often quickly produces in the early stages very high intra-medullary pressure and vascular stagnation, without thrombosis of the vascular supply of the bone marrow (except for the thrombosis developed at the site of the infecting embolus) as evidenced by the quick recovery and absence of bone necrosis when early surgery is instituted. Thrombosis of vessels must at least be a late event and occur after asphyxiation has begun. In dental apical abscesses mere infection does not produce bone necrosis. The infection must be in a sealed bone area, as no abscess develops when the inflammatory products can escape. Moreover a vascular supply is necessary for the production of inflammatory pressures. Vasoconstriction may precede the dilative exudative phase of the allergic reaction. In surface exudates, like the allergic exudative tuberculous pleural effusions, there is no chance of pressures becoming great enough for necrosis, and we also see no thrombosis. The fibrous lung lobule forms a resistant sac when the bronchiole closes from inflammatory reaction. One can easily show this by noting how little, if any, expansion takes place when a lung lobule attached to a tube is dilated with increasing pressure after the lung lobule has once become distended. Again, infection is not a necessary accompaniment of all so-called allergic necrosis as we see in peptic ulcer.

The relationship between cellular exudates and the hypersensitivity reactions

requires further elucidation. In the acute tuberculous exudates there is at present no question but that allergy is an essential element of the reaction. I have stated above that the cellular infiltrations were perhaps separate from the purely exudative allergic phase which was primarily concerned with the exudation fluid, the cellular elements depending upon the nature of the offending organism and the reaction products. These cellular elements vary more or less with the changing local conditions. In non-septic allergic exudates we often find an eosinophilic cellular infiltration along with other cell types. I have been of the opinion for many years that the fundamental process of necrosis was the same in pulmonary tuberculous cavitation and cavitations from other infections, such as we see in lung abscess. In the latter, cellular elements perhaps predominate and are more important in the production of exudation pressures. We can still maintain that exudates produce the lung abscess by tissue asphyxiation through pressure effects, regardless of whether or not hypersensitivity plays an important part here also.

The development of sensitization has been discussed and in the absence of proof, theoretical explanations only can be offered. Sensitization of the autonomic vascular nervous mechanism is our fundamental explanation of the exudation process. Earlier ideas of the necessity of protein elements for the production of such a sensitization no longer explain many of the conditions now included in "allergy." In my estimation, direct or indirect stimulation of the autonomic vascular nervous system by sensory or reflex stimuli may bring about such a sensitization. Just where in the autonomic nervous system sensitization occurs has not been determined. It may occur at the peripheral nerve endings, the ganglia, or possibly in inter-brain centers. There is evidence pointing to each of these possibilities. Whether or not such a sensitized nervous mechanism ultimately always functions through the production of a histamine-like substance may be open to argument. The production of duodenal ulcer from the excessive use of tobacco and opium derivatives has been explained as being due to a paralytic action on the ganglia of the duodenal sympathetics. Cushing has described duodenal ulcers associated with inter-brain lesions which are thought to produce a sympathetic "imbalance" (15). Rokitansky and Virchow were long ago of the opinion that most peptic ulcers were of neurogenic origin.

I prefer to consider pneumonic infection as primarily a bronchial block, with subsequent exudation of reaction products into the obstructed lobe or lobule (13, 14). In some cases abscess results if asphyxiation of the infected area develops. Here again the question arises as to whether the anoxemia is a result of thrombosis or exudation pressure. Thrombosis, as stated above, appears with abscess but must appear late as a result of blood stagnation. When thrombosis does occur early we lack the cellular exudation products and we develop a so-called "dry" gangrene, as in gangrene of the bowel from mesenteric thrombosis, and in many other conditions where the blood supply is shut off without inflammation. Whether allergic reactions require entirely specific stimulation or may be non-specifically stimulated has been frequently discussed. It is generally admitted that non-specific protein elements may produce what appear to be the equivalent of modified specific reactions.

CONCLUSION

Acute tissue necrosis proceeds in a very complicated manner. Anoxemia from tissue reaction pressure is probably the underlying cause of cell death in the conditions described, and there are numerous explanations of events. Allergic manifestations precede such necrosis. The production of cavitations, dental apical abscess, peptic ulcer, and other conditions are described on an allergic basis. In such a controversial subject I consider it necessary that fundamental ideas which bring about the main assertions be considered, even though they

may temporarily divert the reader's attention from the main issues. The subject, as presented, is quite new to many, and for that reason must necessarily cover much ground, which can be given only cursory treatment in such a short paper. It should also be well understood that the above ideas are presented for consideration merely.

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ROENTGEN STUDIES OF TWINS AND TRIPLETS[1]

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DURING the past decade numerous investigations of the physical and mental characteristics of multiple birth siblings have been undertaken, largely with a view to determining the relative effectiveness of heredity and environment upon the individual. In studies of this type it is of crucial importance to determine the monozygotic or polyzygotic character of the multiple births; it is only from identical twins or triplets that conclusions can be drawn as to the effects of heredity. The determination of a monozygotic origin, however, is not at all simple. Numerous factors such as the history of the condition of the birth membranes, the number of placentæ, anthropometric measurements, general physical appearance, finger prints, palm patterns, foot prints, dental measurements, psychological measurements, blood grouping, and sex must be considered. Unfortunately there is no absolute proof on this matter although reasonably positive conclusions may be drawn from a consideration of all the data at hand.

Through the kindness of a number of investigators at the University of Minnesota, including Dr. S. E. Torsten Lund and Miss Ruth Howard of the Institute of Child Welfare, Dr. Royal Gray of the Division of Neurology and Psychiatry, and Dr. Louise Frary of the Department of Pediatrics, I was enabled to submit a number of multiple birth siblings to roentgen examination of the skeleton, paranasal sinuses, mastoids, sella turcica, lungs, and heart. This was done in order to determine, if possible, the help which this type of examination might give in arriving at a definite conclusion as to the identical or non-identical character of twins or triplets. In 1933, at the annual session of the American Medical Association, some of the results of this investigation were presented in the form of an exhibit. Prior to this time there had been few large-scale investigations of twins and triplets by the roentgen method. In 1934, Buschke (1), in an exhaustive monograph, including a review of the literature, reported on a similar study of 50 pairs of twins, four sets of triplets, and one set of quadruplets. In the American roentgen literature, there are practically no papers of this kind, a notable exception being that of Dillon and Gourevitch (5), in 1936.

There are now appearing, particularly in the literature on biology and eugenics, numerous papers detailing similarities of identical twins and triplets. In many of these the roentgen method of study is used. Recent reviews of the literature by Joppich (10), McBroom and Gray (13), Lund (12), and Kühne (11) give some idea of the extent of the interest in this subject. The latter, for example, has written a complete monograph on the roentgen study of the spines of twins, with a view to establishing whether or not the variability of development of the spine is hereditary or acquired. In a similar way, Gourevitch (6) studied the heart size in both monozygotic and dizygotic twins to determine the effects of heredity on this portion of the anatomy. Dillon and Gourevitch (5) examined the mastoids, paranasal sinuses, and sellæ turcica in similar fashion, while Wagner (15) has studied roentgenograms of the whole skull. Schinz (14), in a consideration of the hereditary nature of tumors in man, has collected all the reports of twins in whom similar and dissimilar tumors were found. Numerous other applications of this

[1] Presented at the Fifth International Congress of Radiology, Chicago, Illinois, Sept. 13–17, 1937.

method of investigation have been made. In addition, there are many other reports of individual cases and studies of individual variations. The latter are illustrated by the papers of Buschke (2, 3) and Haffner (7). The complete literature is far too voluminous for further consideration and has already been well reviewed in the various articles cited above.

The hereditary nature of the tendency to bear multiple children has been clearly established by numerous investigators. The opinions on this matter are summarized by Buschke (3, 4). He also discusses in some detail the manner in which twins and triplets chance to occur. While the mechanism in man is not positively established, the theories are reasonably well supported by factual evidence. For purposes of clarity, it may be well to describe briefly the possible means by which various types of multiple births may take place. Fertilization by two separate spermatozoa of two simultaneously appearing ova, from one or both ovaries, will result in dissimilar or non-identical twins. Likewise non-identical twins may occur from the fertilization of one ovum which then divides, the daughter cell being fertilized by another spermatozoon. Identical twins are the result of the fertilization of one ovum by one spermatozoon; as the cell divides, the first two products separate completely, two distinct fertilized ova being produced. The twins from such an ovum partake equally of the chromosomes of both parents and are, therefore, identical.

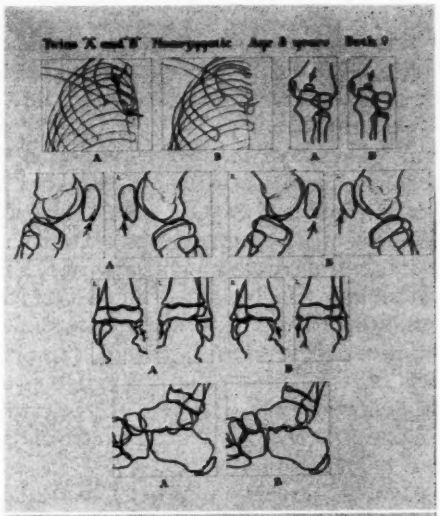
The occurrence of triplets is a more complex process. Two ova may be fertilized by two spermatozoa. One of these may then divide, with identical twins resulting, while the other ovum goes on to normal development. The product would be dizygotic triplets, two of the set being identical, one, non-identical. It is possible for both fertilized ova to divide and for one of the four products to fail of maturity; the final result will be the same as above. Fertilization of three ova by three different spermatozoa would, of course, result in trizygotic triplets, all non-identical. A similar result might occur if one ovum was fertilized, divided unequally, the daughter cell then being fertilized again, while simultaneously another ovum was fertilized by a third spermatozoon. While it has never been positively established in man, it seems reasonable to assume that identical triplets originate from one ovum, fertilized by one spermatozoon. This proceeds to divide, first into two and then into four cells, all of which develop separately but have the same chromosomal constituency. From this would come uniovular quadruplets. If, however, one of these cells fails to mature, three embryos of exactly the same heritage would remain, a set of monozygotic triplets. While these are rare, they undoubtedly occur.

It is evident that in twins we may see identical, partially identical, and non-identical pairs. The latter two are considered together as dizygotic twins. Amongst triplets there may be monozygotic identical sets, dizygotic sets, composed of one pair of identical twins and one odd member, and trizygotic sets in which all the members are non-identical.

Roentgen examination of the anatomy of twins and triplets may, in many cases, constitute a great aid in determining their mono-, di-, or trizygotic origin. Striking similarities in the rate of development of the skeletal structure, in the form, size, and position of the ossification centers, in the form, size, and development of the paranasal sinuses and mastoids, in the size and shape of the heart, and in the presence of anatomical variations all serve to indicate the uniovular origin of multiple birth siblings. In addition to this, in those cases in which the monozygotic origin of twins and triplets has been conclusively established by other evidence, roentgen studies may give valuable information as to the hereditary or acquired character of certain anomalies and anatomical variations such as the anomalous lobes of the lung, defects in the vertebral

laminæ, multiple epiphyseal centers, extra ossicles and others of a similar nature.

The data on five pairs of twins and nine sets of triplets have been collected for this study and some of these will be reviewed in detail with illustrations. It should be noted that the clinical and anthropometric observations, as well as some of the roentgen findings, in many of these multiple births have been presented in greater detail by others, as will be noted below. For this reason, no effort will be made in the course of this paper to discuss the clinical and anthropometric findings in these twins and triplets in detail. Only a summary of the important roentgen findings can be given, but emphasis will be placed on the striking similarities and striking differences which are present. It should be noted that, independently of the roentgen findings, an extensive effort has been made in each instance to determine, by numerous measurements and tests, the identical or nonidentical character of the twins or triplets. It is not possible in all cases to be absolutely certain as to this, and when doubt exists it will be so indicated. In general, the roentgen findings have correlated extremely well with the conclusions arrived at by other methods of approach.



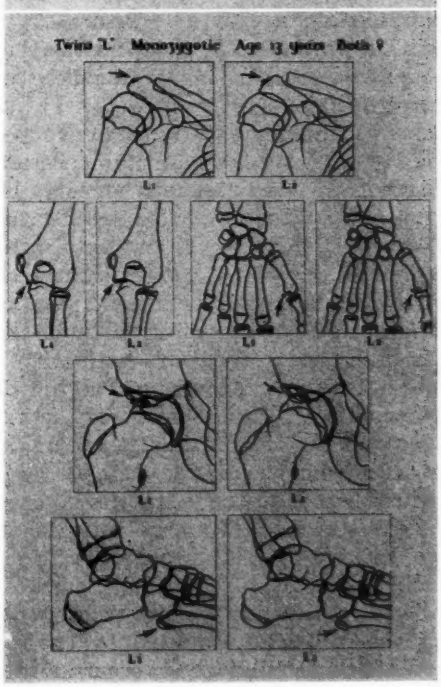


Fig. 1 (*above*).
Fig. 2 (*below*).

ROENTGEN STUDIES OF TWINS

A set of female, epileptic twins (A, B), appearing by most tests to be monozygotic, which have been previously reported by McBroom and Gray (13), were submitted to roentgen examination of the entire skeleton, the heart, and lungs. Tracings of the more important roentgenograms are shown in Figure 1. An exact similarity of epiphyseal development was found throughout the skeleton. This is demonstrated particularly well in the elbow, knee, ankle, and foot. The equality in size of the epiphyses in the elbow and the exactly similar fissuring of the epiphysis of the calcaneus are notable.

A number of rather unusual anatomical variations occurred and these presented the most interesting findings in this pair of twins. Both of them exhibited an extra ossification center for the patella on its anterior surface. This was bilateral and represents a rather unusual

developmental variation. The uniformity of this extra nucleus in all four knees is striking. Likewise there occurred an independent center of ossification for the tip of the internal malleolus, bilaterally, in both sisters. The latter variation is found ordinarily in about 8 per cent of normal females at this age. The coincidence of its occurrence as well as that of the extra patellar ossification in both of the twins is highly significant of the hereditary nature of these two anatomical variations. On the other hand, the presence of two such exactly similar extra ossicles occurring in both of the twins emphasizes the uniovular character of this pair.

Another rather unusual anatomical variation, an azygos lobe fissure of the right lung, occurred in twin A alone. No evidence of such a fissure could be detected in the lung of twin B (Fig. 1). So far as I can determine, no previous report bearing on the hereditary or acquired character of this uncommon anomaly has been made. In view of the fact that these twins were almost certainly monozygotic in origin, the azygos lobe of the lung would appear to be a non-hereditary variation. It is interesting to note that this conclusion corresponds with what is known by the embryologists of the development of such anomalies of the vascular system; namely, that they are due to disturbances occurring *in utero*.

Comparison of the sinus development showed striking differences between the two twins. This is consistent with the findings reported by Dillon and Gourevitch (5) and indicates that sinus development may be profoundly affected by environmental or accidental factors occurring after birth. The mastoid development, however, was reasonably similar. The size and shape of the heart showed minor differences between the two girls; the exact significance of this is not apparent.

A second pair of presumably identical twins (L), both females, aged 13 years, were submitted to general roentgen examination. The tracings of their roentgenograms are shown in Figure 2. A comparison of the epiphyseal development of the extremities in these twins shows almost exact similarity. The multiple, small, irregular ossification centers of the epiphyses of the acromion process, which are not infrequent, are extremely similar in the two twins. Likewise, the rather bizarre development of the epiphysis of the trochlea was present in both in an exactly similar fashion. The similarity of appearance of the sesamoids at the metacarpo-phalangeal joint of the thumb is also notable. There is also observed rather markedly irregular os acetabuli, again present in both twins. It may be noted that the epiphysis of the tuberosity of the fifth metatarsal is developed to exactly the same degree in both sisters. When it is realized that this epiphysis is extremely variable in its time of appearance in ordinary siblings, the striking similarity of these two girls is apparent. There were no outstanding anatomical variations in twins L, the remainder of the examination indicating a relatively normal, similar development.

By contrast with the two pairs of identical twins, a pair of dizygotic, nonidentical twins (M), both females, aged 9 years, are presented in some detail. The tracings of their roentgenograms are shown in Figure 3. Comparison of the films of the elbow and foot show generally larger sized bones in M_2. The difference in size of the epiphyses in the elbow, the differences in character of the epiphysis of the trochlea and the greater degree of union of the epiphysis of M_2 as compared to M_1 is very striking. It should also be noted that the epiphysis of the tuberosity of the fifth metatarsal is present in M_2 and not in M_1. There are, in addition, a number of transverse lines of density in the distal end of the tibia in M_1, not present in M_2; this no doubt is of significance only as an indication of a greater number of infections and more retardation of growth. The striking dissimilarities which are present between these two sisters of exactly the same age are more characteristic of

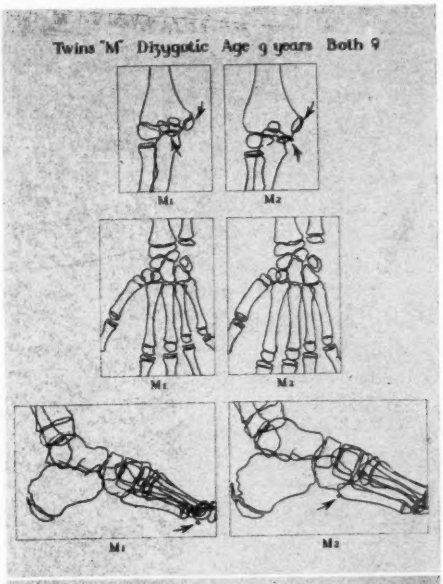
our general experience with regard to the development of the skeleton in children and contrasts sharply with the exact similarity previously noted in the monozygotic pairs.

Two other pairs of non-identical twins were studied; both were females, one aged six and one-half months and the other seven years. In both of these, dissimilarities of epiphyseal development were apparent, similar to twins M, but without such extreme variations. It is apparent at once from an examination of both the twins M (Fig. 3), and the numerous films made on other pairs of non-identical twins that considerable variation in epiphyseal and bone development may occur in siblings of exactly the same age. This emphasizes all the more the value of the roentgen examination in establishing the identical or non-identical character of twins.

ROENTGEN STUDIES OF TRIPLETS

Roentgen examination of the entire skeleton, including the spine and skull, and of the thorax, was made in a set of female triplets (X, Y, Z) aged nine years. Based on all the assembled evidence, these appeared in all probability to be of monozygotic origin. They have been reported in great detail by Lund (12), who studied them intensively both from the physical and psychological standpoint. Studies of the skeleton of identical triplets have been reported very rarely (3, 4), hence the findings observed in these sisters are of considerable interest.

Tracings of many of the roentgenograms of the set of presumably identical triplets are illustrated in Figure 4, but the films of the spine are not included in this drawing. The paranasal sinus development is seen to be more similar than is usually found in children of exactly the same age. Nevertheless there are distinct differences which may be related to the evidences of sinus infection found in two of the sisters, the third being normal. It seems reasonable to suppose that the



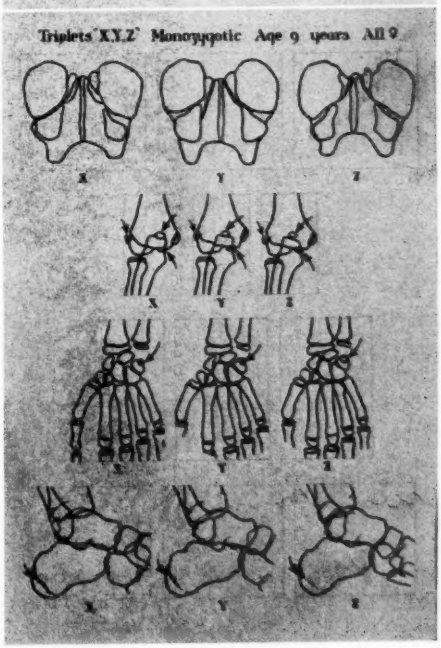


Fig. 3 (*above*).
Fig. 4 (*below*).

effects of acquired infections may account for the differences which are apparent. On the other hand, there was a striking similarity in the development of the mastoid processes in all three with only

minor differences. Likewise the development of the sella turcica was about uniform in all three of the triplets. These findings are consistent with those of other investigators (5).

The epiphyses about the elbow, in the wrists and hands, and the carpal centers have an almost equal development. Careful measurements by Lund (12) of the size of the carpal centers of ossification show a striking similarity. The exactly similar fissuring of the epiphysis of the calcaneus should be noted. It is interesting to observe that this fissure was present in the left foot only of X and Y and in the right foot only of triplet Z. This suggests the mirror effect which is often found in identical twins.

Slight differences in ossification of the pelvis were observed, especially as to the degree of union of the three components of the acetabulum, but the differences were minor. Likewise there were slight differences in the form of the condyles of the tibia. In triplet Z there was found a phalangeal epiphysis in the small toe not observed in the other two. On the whole, the skeletal development was much more uniform than in non-identical females of the same age.

The shape of the heart was much the same in all three girls, but there were minor differences in heart size. The lungs appeared substantially the same.

The lumbosacral region presented interesting differences. In triplet X there was normal development of the lumbosacral segment of the spine. In triplet Y a congenital anomaly, consisting of a defect in the lamina of the fifth lumbar vertebra and a fusion of the left half of the lamina with that of the fourth lumbar vertebra, was found. In triplet Z an anomaly of somewhat different character, a defect in the lamina of the first sacral vertebra with a partial lumbarization of its transverse processes, was present.

Here again we find distinct differences in the anomalies of apparently monozygotic siblings. It is suggested from this that defects in the laminæ of the vertebræ, which are so common, and possibly other anomalies of this region are not hereditary. This also corresponds with our knowledge of the embryological development of this type of anomaly which is thought to develop *in utero*. Kühne (11) likewise found from a study of twins that certain types of variations in the spine do not appear to be of genetic origin. The hereditary factor seems to influence the general arrangement and configuration of the spine. Haffner (7) reported a pair of presumably monozygotic twins both of whom had intercalated wedge vertebræ. This type of anomaly, however, is of a different character, so that his report offers no contradiction to the findings reported above. In the twins described by Harpin (8) defects in the lamina were observed in both but the identity of the twins was not clearly established.

By way of comparison with the set of monozygotic triplets, six sets of dizygotic triplets were examined. All the triplets herein reported have been the subject of a special study by Miss Ruth Howard (9). The dizygotic triplets form an exceedingly favorable group for this type of study; they present contrasting pictures of skeletal development within the same group. In one such set we are afforded the opportunity of observing the differences in development of non-identical twins and the similarities of identical twins, all of exactly the same age, family background, and with a similar environment. The influence of the genes is thus brought out in startling fashion.

For purposes of illustration, triplets H, J, C, and G will be used. Tracings of various roentgenograms of the skeleton of triplet H are shown in Figure 5. It will be noted that H_2 and H_3, considered identical, were both males, 13 years of age. H_1 was a female and the difference in sex at once indicates positively that the set of triplets are not uniovular. The exact likeness which the roentgenograms of the elbows, hands and wrists, hips, and feet of the two male members of the set bear each other, indicates clearly their

monozygotic origin. On the other hand, the same parts of H_1, the female member of the set, all show the more advanced ossification which is to be expected because of the difference in sex. It is to be noted that all the epiphyses about the elbow are still distinct in the males while only the medial epicondyle remains ununited in the female. In the hand there is present a sesamoid bone at the metacarpo-phalangeal and interphalangeal joints of the thumb in H_2 and H_3, while in H_1 only one sesamoid is apparent, that at the metacarpo-phalangeal joint. An os acetabuli is present in the hips of the identical pair and not seen in the non-identical member of the set. The size and position of the epiphysis of the tuberosity of the ischium is likewise similar in the male members, dissimilar in the female member of the set. The foot shows a striking equality in size, shape, and position of the bones and their epiphyses in H_2 and H_3 with almost as striking an inequality in H_1. Particularly to be noted are the epiphysis for the tuberosity of the fifth metatarsal, present in H_2 and H_3, probably already united in H_1, open epiphyseal lines in the phalanges of H_2 and H_3 which in H_1 are closed except for the proximal phalanx of the great toe. The remaining portions of the skeleton gave consistent findings although those illustrated were the most obvious.

A set of dizygotic triplets (J), nine years of age, all of whom were female, is illustrated in Figure 6. J_1 and J_3 appeared to be identical, J_2, non-identical. The paranasal sinuses are illustrated here and indicate no apparent similarity, a finding consistent throughout the study. In the elbows, however, striking similarities and differences may be observed. It is apparent that ossification is more advanced in J_2 than in J_1 and J_3 in spite of their similar sex and age. The epiphyses for the capitulum, medial epicondyle and head of the radius are all larger in J_2 than in the identical pair. Likewise the osseous center for the epiphysis of the

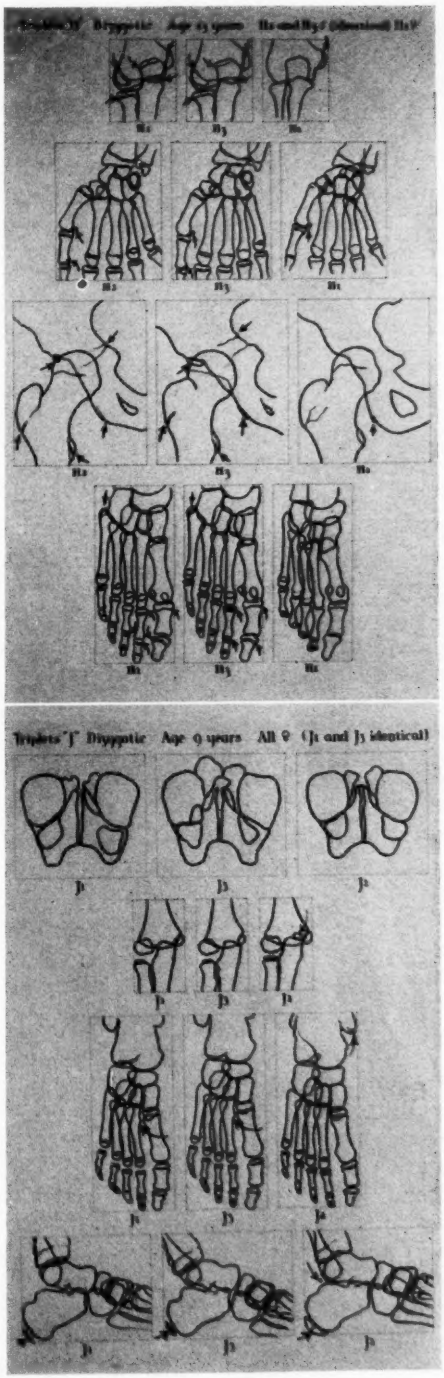


Fig. 5 (*above*).
Fig. 6 (*below*).

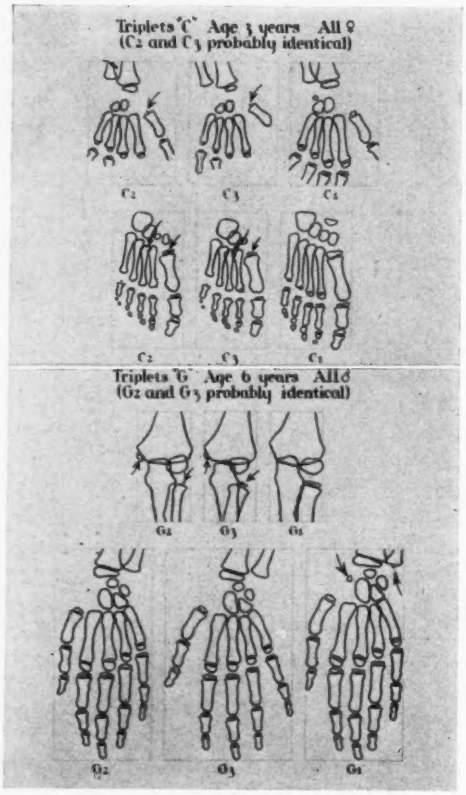


Fig. 7 (*above*).
Fig. 8 (*below*).

olecranon has already appeared in J_2 while still absent in the other two. The foot shows similar epiphyseal development but here there are two anatomical variations of considerable interest. The first, a small exostosis on the medial side of the second metatarsal, in exactly the same location in J_1 and J_3, is absent in J_2. The second, a separate ossification center for the tip of the medial malleolus, is present in J_1 and absent in the other two. The epiphysis of the calcaneus is the same size in the identical pair, much larger in the odd member of the set. The latter shows the early appearance of an os trigonum, another anatomical variation which is not apparent in the identical pair.

In this group, at least one anatomical variation, an exostosis of the metatarsal, is clearly shown to be hereditary in origin by its exactly identical appearance in both of the monozygotic twins. It would be an extremely rare coincidence to discover this unusual finding in precisely the same location in both of these twins if they were not uniovular and the variation were not chromosomal in character. On the other hand, the presence of the other two variations, the os trigonum and the extra epiphysis for the medial malleolus, in one member of the set alone, helps to establish definitely the dizygotic origin of these triplets.

Triplets C were three years of age and all female. They appeared by most tests to be dizygotic, with C_2 and C_3 considered probably identical. In Figure 7 are illustrated tracings of roentgenograms of the hands and feet only, as these alone showed significant similarities and differences. Again there is apparent a marked advancement in the degree of ossification of one member of the set, C_1, as compared to the other two, in spite of the uniform sex of all three. The irregularities, atypical pseudo-epiphyses, at the proximal ends of the metatarsals, of C_2 and C_3, which are almost duplicated, are in contrast to the more average ossification of the metatarsals of the odd member of the set.

The final set of dizygotic triplets to be illustrated were all males, six years of age. Tracings of the roentgenograms of the elbows, hands and wrists are shown in Figure 8. The findings, in general, are of the same character as those described above with certain interesting minor differences. It is apparent at once that the development of the epiphyses about the elbow is somewhat more advanced in G_2 and G_3 than in G_1, the odd member of the set. In the identical pair the epiphysis for the medial epicondyle is present while absent in the non-identical triplet. On the other hand, the epiphysis for the head of the radius is much larger in the latter than in the other two. The same similarities and differences are present in the hands where the ossification of G_1

is generally more advanced than that of G_2 and G_3.

Two sets of apparently trizygotic triplets were examined. The roentgen findings in one of these, triplets F, all female, sixteen years of age, are illustrated in Figure 9. The various anthropometric data on these three girls were at variance and there is no way of determining with complete certainty that they were triovular in origin. Most of the findings support this thesis. Roentgenologically, also, there is considerable difficulty, largely because ossification of the epiphyses had proceeded so far that distinction on this basis was hampered. Nevertheless certain differences appear which are demonstrated by the tracings of the roentgenograms shown in Figure 9. Note should be made particularly of the differences in the degree of union of the distal epiphyses of the radius and ulna, all three being at variance. Likewise the number and distribution of the sesamoids are unlike in all three; F_1 has four, F_2, only two, while F_3 has five of unusual character. The dissimilarity of the irregular epiphyses of the transverse processes of the vertebræ is clearly apparent. Here again there is a laminal defect in one of the trio, but this probably has little significance. The degree and character of the ossification of the epiphysis for the tuberosity of the ischium differs to a moderate degree. Finally, there is an accessory scaphoid ossicle in the foot of F_2 which is not found in either of the other two girls. A critical study of all three indicates the possibility that F_1 and F_3 are identical, with F_2 as the odd member of the set. This was also slightly indicated by the anthropometric data but the preponderance of evidence favors a trizygotic origin. There are differences in this set which might be expected of sisters of exactly the same age who originate from different ova.

Three other sets of triplets, one possibly trizygotic and two probably dizygotic, were studied with similar results. Considering all nine sets of triplets, it seemed possible from the roentgenologic data alone to make a fairly definite statement as to the identical or non-identical nature of the members in six sets. As to the other three, there was considerable doubt. In general, these results were in agreement with the conclusions drawn from the criteria mentioned in the first paragraph. Certain cases, in which the anthropometric and clinical data were ambiguous, gave very definite roentgenologic conclusions. In other instances the reverse was true. A combination of both types of information, in almost all instances, yielded a definite determination as to the mono-, di-, or trizygotic nature of the triplets.

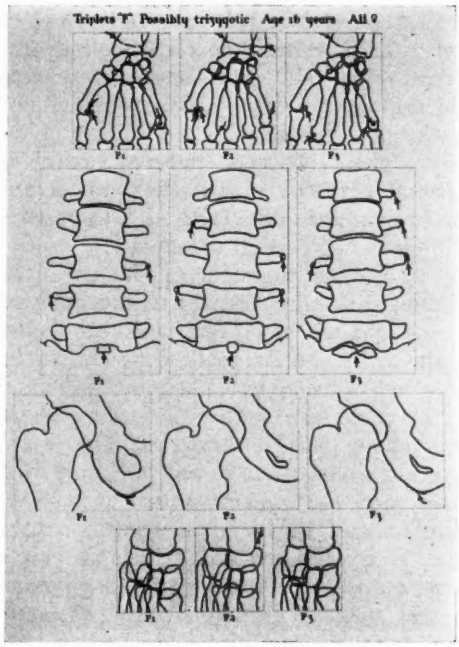


Fig. 9.

SUMMARY

1. Roentgenologic studies of the skeleton, paranasal sinuses, mastoids, sella turcica, heart, and lungs of five pairs of twins, including two monozygotic and three dizygotic pairs, and nine sets of triplets, including one probably monozygotic, two probably trizygotic, and six dizygotic sets, are reported.

2. The identical or non-identical character of these multiple birth siblings had been previously established to a considerable degree by various clinical and anthropometric tests.

3. The roentgen findings were in general agreement with the clinical and anthropometric data, although there were differences in certain cases.

4. The development of the paranasal sinuses differed markedly in the identical twins and triplets. The mastoids tended to be fairly similar, while the sella turcica tended to develop in very similar fashion.

5. A certain similarity in cardiac development was observed in the monozygotic siblings but it was not marked.

6. In the monozygotic twins and triplets and in the monozygotic pair of the sets of dizygotic triplets, skeletal development, both as to its rate and character, was observed to proceed along strikingly similar lines. In the non-identical siblings marked differences were present. The similarities and differences were most obvious in the younger children at the ages when many epiphyses are present.

7. Certain anatomical variations were encountered in both members of pairs of identical twins, namely, an extra ossicle for the patella, a separate epiphysis for the tip of the medial malleolus of the tibia, variations in the number of ossification centers for the epiphysis of the acromion process of the scapula and for the trochlea of the humerus, the os acetabuli, pseudo-epiphyses of the metatarsals, and an exostosis of the metatarsal.

8. An azygos lobe of the right lung was found in only one of identical twins.

9. Anomalies of the lumbosacral segment of the spine were found of varying character in two of three members of a set of monozygotic triplets.

CONCLUSIONS

1. The roentgen method is of great assistance in determining definitely the identical or non-identical character of twins or triplets. When combined with clinical and anthropometric data, roentgen findings may produce a conclusive determination of this important question.

2. Roentgen study of multiple birth siblings whose monozygotic origin is known may reveal data leading to a conclusion as to the hereditary or non-hereditary nature of anomalies and anatomical variations.

3. From the findings in this series of cases it seems probable that the rate and character of growth of the skeleton and anatomical variations such as extra ossicles, extra ossification centers, irregularity of ossification centers, exostoses, of a certain type, and the number and location of sesamoids are of hereditary origin and are likely to be exactly similar in monozygotic siblings.

4. Such anomalies as the azygos lobe of the lung and defects in the laminæ of the vertebræ do not appear to be hereditary, the number of cases being insufficient to allow one to draw positive conclusions.

5. The roentgen examination of multiple births is of great value in the study of the effects of heredity and environment.

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SPONTANEOUS PNEUMOTHORAX[1]

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INTRODUCTION

SPONTANEOUS pneumothorax has long been associated with pulmonary tuberculosis, particularly as a complication of the more advanced active stages of that disease. The first to describe pneumothorax was Itard, in 1803, and Lænnec is said to have been the first to have diagnosed it and to have fully described the physical findings upon which a diagnosis could be made. Prior to the advent of x-ray examination and fluoroscopy and before the use of this diagnostic aid had become universally prevalent, there was an absence of case reports on spontaneous pneumothorax. In the last two decades, case reports of non-tuberculous spontaneous pneumothorax began to appear in greater numbers. Of special interest is the increasing number of cases occurring in otherwise apparently healthy individuals without any antecedent history or physical stigmata of tuberculosis or evidence of any other pathologic condition of the lung. These are the so-called idiopathic or essential types of spontaneous pneumothorax.

In reviewing the literature on this subject it is apparent that many observers use the term "spontaneous" in its narrower sense, namely, that in which there is no evident internal or external cause for the pneumothorax. "Spontaneous pneumothorax" embraces all cases whether primary or secondary to pathologic changes, in contradistinction to the artificial or induced pneumothorax. "Idiopathic or essential spontaneous pneumothorax" is the term used in cases in which there is no evident cause for the condition.

[1] Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13–17, 1937.

ANATOMY

The so-called "lung unit" is the "lobule" (Fig. 1). Air enters the lobule through a respiratory bronchiole which is a branch of a larger bronchiole. The respiratory bronchiole leads into several alveolar ducts, each of which branches out into from three to six atria. Each atrium leads into an alveolar sac, which finally ends in the terminal alveoli. Numerous alveoli communicate with one another. However, there are also scattered alveoli along the walls of the respiratory bronchioles. These latter alveoli have a more direct communication with the main bronchi.

The visceral layer of the pleura is very thin and firmly attached to the lung. It is composed of an outer mesothelial layer of flat cells which rests on a thin layer of fibrous tissue, beneath which is a subserous layer of fibrous tissue. Subjacent to this layer are the pulmonary alveoli which, with their blood, nerve, and air supply, compose the lung lobule.

The pleural cavity is the space between the visceral and parietal pleura. Normally it is negligible during a deep inspiration, as the visceral layer glides over the parietal layer. During expiration the space is actual, and varies from one-half to one inch in extent.

The lungs are kept distended by virtue of the negative pressure normally maintained in the pleural cavities. The negative pressure is produced by the elastic recoil of the lungs always tending to collapse, and thus pulling on the semirigid wall of the closed thoracic cavity. Various investigators have estimated this negative pressure to be from -3 to -6 mm. during expiration and from -5 to -10 mm. of mercury, during inspiration.

PATHOLOGY

Pneumothorax is the accumulation of air in either or both pleural cavities, associated with a varying degree of lung compression. Displacement of mediastinal structures takes place to the opposite side in complete unilateral pneumothorax, unless the mediastinum has become fixed by a pathologic process. Spontaneous pneumothorax is accidental and incidental to pathologic change and in the idiopathic cases is a result of "natural wear and tear." The direct cause of spontaneous pneumothorax is a tear in the visceral pleura and subjacent lung structure. There are three types, namely:

1. *Open Type.*—Air enters and leaves the pleural cavity through the point of rupture in the lung during inspiration and expiration, respectively. An amount of air sufficient to overcome the negative pressure is thus introduced; the lung collapses and the quantity of air in the pleural cavity remains stationary until slow absorption of air and lung expansion commences, whereupon the tear in the lung and pleura heals.

2. *Closed Type.*—The point of rupture in the lung becomes sealed quickly. The amount of air thus admitted into the pleural cavity before closure of the tear is variable, depending upon the size of the rupture and the amount of positive pressure necessary to cause sufficient lung collapse to permit such closure. This type usually causes only partial collapse and milder symptoms.

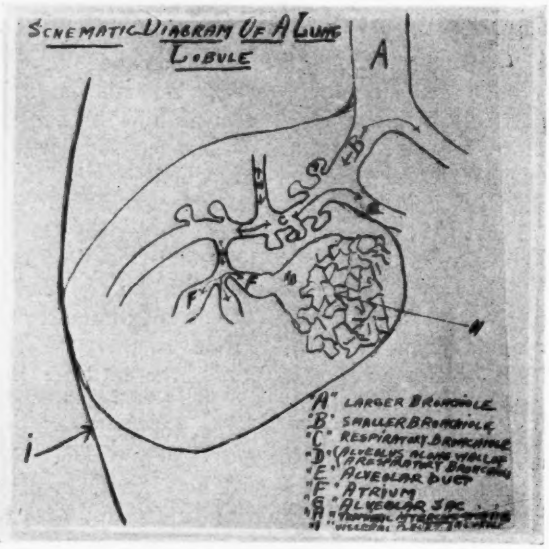

Fig. 1

3. *Valvular Type.*—In this type, entrance but not exit of air into the pleural cavity is permitted. Air thus continues to accumulate, being "sucked" in with every inspiration and affording no means of exit during expiration. The mediastinum is displaced to the opposite side, the opposite lung becomes compressed, and the symptoms quickly become very severe, necessitating immediate relief by means of deflation.

ETIOLOGY

Primary, essential, or idiopathic spontaneous pneumothorax occurs in otherwise apparently healthy individuals. It is comparatively rare. It occurs more com-

monly in the young. Adult males and females are rarely affected. No greater exertion than ordinary respiration seems necessary to produce it and the cause, if any, is difficult to find and impossible to prove.

Secondary spontaneous pneumothorax is secondary to: tuberculosis of lung or pleura or both, the cause of from 60 to 90 per cent of all spontaneous pneumothorax, according to various authors; pathology of any of the organs in the mediastinum or pleura, *e.g.*, newgrowths of the trachea, esophagus or mediastinum, bronchi or pleura, pneumonia, pertussis, gases formed in the pleural cavity as a result of infection with the *Bacillus aerogenes capsulatus;* attempt at artificial pneumothorax. When secondary to pulmonary tuberculosis it is more common in far advanced cases. Not infrequently it occurs in minimal cases which have been arrested for many years. When partial and localized it is usually in the vicinity of an active focus, and thus by selective collapse aids in the healing of the disease.

It is asserted that spontaneous pneumothorax has greatly increased since artificial pneumothorax has been extensively practised. Fishberg and Brauer and Spengler state that spontaneous pneumothorax may occur when the needle for artificial pneumothorax causes laceration of the visceral pleura and lung, or when inflation of air causes separation of adherent pleura and thus lacerates the visceral pleura and lung. Watterson (14) states this accident occurred only once in 200 paracenteses on 30 patients in his service. It is his belief that "coincident rather than resultant rupture of the visceral pleura during artificial pneumothorax is probable in many cases."

In recent literature cases are reported in infancy and childhood, both of the primary and secondary variety, tuberculosis seldom being a factor.

THEORIES OF FORMATION

The following hypotheses have been advanced as to the formation and mechanics of idiopathic spontaneous pneumothorax:

1. Rupture of a pleural tuberculous focus, at times so small as not to be demonstrable by any of the diagnostic methods at our command.
2. Rupture of a pleural adhesion
3. Rupture of an air bubble resulting from emphysematous vesicles or bullæ.
4. The authors' theory depends on the location of a visceral pleural defect during natural "wear and tear." It is based on the assumption that no matter what the cause of pleural and lung laceration, the location is what determines whether or not pneumothorax takes place. The size of the laceration is not a determining factor. Osler states that pneumothorax rarely follows fracture of ribs, even though the lung may be torn. On the other hand, a very small laceration, if in the proper location, will produce it. What constitutes optimum location for the production of pneumothorax? If the tear, be it small or large, involves bronchi, bronchioles, respiratory bronchioles, or even alveoli lining the wall of a respiratory bronchiole (Fig. 1), then the atmospheric pressure in the trachea and bronchi by fairly direct communication exerts sufficient force to drive air into the pleural cavity and cause a pneumothorax. On the other hand, a laceration may involve numerous intercommunicating alveoli and not produce a pneumothorax. This is due to the fact that communication of these alveoli with atmospheric pressure in the trachea and bronchi is very remote and the air pressure in these alveoli is negligible.

The authors are of the opinion that in normal respiration the gliding of visceral over parietal pleura causes a continuous shedding and regeneration of the pleural mesothelium. A slight defect in the regeneration at some point, if located in a portion of a lung lobule or lobules involving one or more bronchioles referred to above, will, when accompanied by a respiratory effort of greater or lesser severity, cause a tear in the visceral pleura and a pneumothorax will follow. Of course the lack of probability

of such an accident in so select a location is what makes true "idiopathic" spontaneous pneumothorax of rare occurrence.

DIAGNOSIS

Sudden sharp pain in one side of the chest accompanied by increasing dyspnea and possibly collapse suggests spontaneous pneumothorax; physical signs and x-ray examination corroborate it. If a healthy individual or one having slight pulmonary or pleural pathology, up and about his daily routine, is suddenly seized with the above-named symptoms, spontaneous pneumothorax must be suspected. The diagnosis can often be made on the characteristic symptoms and general appearance of the patient if seen shortly after the onset. The physical signs are variable and in themselves are not conclusive, unless in complete collapse with displacement of the mediastinum. The most important diagnostic aid in suspected cases and corroborative proof in diagnosed cases, is the fluoroscope and roentgenogram.

PROGNOSIS

1. If essential, or secondary to slight pleural or pulmonary pathology, recovery is the rule.

2. Spontaneous pneumothorax complicating far advanced active pulmonary tuberculosis, is a very serious and usually terminal condition.

3. When complicating pneumonia, it is serious though not necessarily hopeless.

4. When secondary to malignancy, the prognosis is that of the primary condition.

From the standpoint of pathology the prognosis is much better in the open and closed types. The valvular type causes the most severe symptoms, and on account of treatment necessary makes this type more prone to complications, *e.g.*, serous or purulent effusion.

TREATMENT

Uncomplicated spontaneous pneumothorax with symptoms not distressing requires only rest and symptomatic medication. If dyspnea becomes marked and the pneumothorax side is greatly distended with air, as is almost always the case in the valvular type, deflation should be resorted to. The method described by Watterson (15) is a very practical one. The Robinson artificial pneumothorax apparatus is reversed, the proximal bottle being filled with water while the distal bottle is dropped to a lower level. The water siphons from the proximal into the distal bottle, creating a vacuum in the proximal bottle. Manometric readings are made before deflation is begun and after withdrawal of every 200 c.c. of air, which is measured by water displacement in the proximal bottle. If the apparatus is not available, a trocar and cannula may be used and, where air re-accumulates rapidly, a rubber tube inserted through the cannula may have to be left *in situ* for some time. The amount of air withdrawn varies from 800 to 3,000 c.c. The operator should never withdraw all the air, any more than he would think of tapping a chest dry of an effusion. In far-advanced active, pulmonary tuberculosis deflation should be performed to relieve respiratory distress. In this connection, Stewart (16) of Veterans Administration Facility, Castle Point, N. Y., reports a very interesting case, in the Medical Bulletin of the Veterans Administration, March, 1932. A patient who had a far-advanced lesion with cavitation and moderate toxicity, in a fit of temper, attempted to climb the wall of a toilet which was locked. He collapsed and was found to have a spontaneous pneumothorax which almost asphyxiated him. He was pulseless when put to bed. The urgency of the case caused the ward surgeon to introduce two non-sterile needles through non-sterile skin into the pleural cavity. The needles were anchored and allowed to remain undisturbed for three weeks. No infection followed. His condition improved remarkably. He became afebrile, put on weight, and his symptoms ameliorated rapidly. Prior to this accident, his two-year stay at the institu-

tion had been marked by continuous retrogression.

CASE REPORTS[2]

Case 1. Male, 30 years of age, had a pulmonary hemorrhage on Aug. 15, 1920. He was treated in private sanatoria and at Veterans' Hospital, New Haven, until July, 1922, when he was discharged as an arrested case. There was also a history of syphilis in 1916, for which he received 29 salvarsan injections and 125 mercury injections. Several blood Wassermann tests in 1921 and 1922 were negative. Examination Jan. 3, 1923, as on several previous occasions, disclosed signs of small healed tuberculous lesions at both apices, corroborated by x-ray examination.

The onset of spontaneous pneumothorax was on March 24, 1923, with sudden sharp agonizing pain in the left chest as the patient was alighting from a subway train. He had to be taken home in a taxi where he remained for two days, suffering from intense pain in the left chest and some dyspnea. He was in bed one week. The symptoms gradually subsided and abated entirely in three weeks.

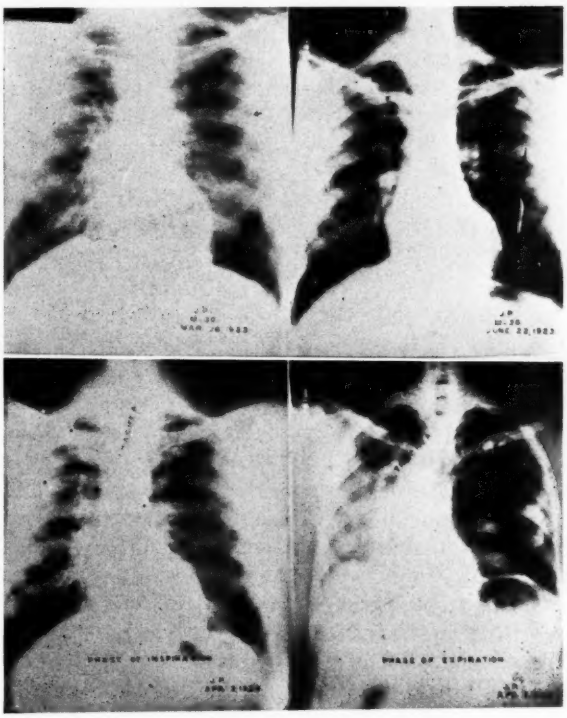

Fig. 2-*A* (*top*). Case 1. Partial left pneumothorax in outer third of chest with slight shift of the mediastinum.
Fig. 2-*B*. Complete re-expansion of left lung.
Fig. 3-*A* (*bottom*). Case 1. Partial left pneumothorax during inspiration.
Fig. 3-*B*. The same during expiration showing exaggeration of pneumothorax and mediastinal deviation.

When seen two days after this onset the patient looked pale, but not acutely ill. He walked slowly, appeared anxious, and favored the left side while walking or moving. Temperature and pulse were

[2] From (*a*) U. S. Veterans Administration of New York City; (*b*) Tuberculosis Clinics of Department of Health, New York City.

normal; respiration rate, 22 per minute. The chest showed marked lagging on the left side, although the right side was also restricted in movement. Fremitus was diminished on the left side. Resonance was impaired above the right clavicle and spine of scapula. Resonance on the left side was not altered. There were diminished breath sounds over the entire left side but no râles. The heart was apparently not displaced. X-ray examination on March 26, 1923 (Fig. 2), two days after the onset, revealed a well-defined area of lessened density and absence of lung markings involving the outer third of the left chest from apex to base. There was also evidence of slight shifting of the mediastinum to the right.

Another film taken April 3, 1923 (Fig. 3), disclosed the same area of absent lung markings, and also showed the flexibility of the mediastinum during the expiratory phase. The area of absent lung markings was greatly increased, due to the shifting of the mediastinum and the left lung to the right. This encroachment on the right chest cavity caused a certain amount of compression of the right lung during this phase of respiration. Roentgenographic examination, June 22, 1923 (Fig. 2), showed complete re-expansion of the left lung and calcific deposits at both apices.

The diagnosis was healed tuberculosis, both apices; spontaneous pneumothorax, partial, left chest. Follow-up re-examinations to date show this patient in good health and symptom-free.

Case 2. Male, 24 years of age, law student, gassed in the World War, but with no residuals. No history of tuberculosis was elicited. When examined for a cold, two months previously, no pulmonary pathology was noted.

On Sept. 25, 1923, while getting off a train the patient was seized with excruciating pain in the left chest, associated with marked dyspnea. He was removed by cab to Bellevue Hospital, where he remained for two hours. The severe pain eased gradually. However, shortness of breath and pain in the left chest lasted 80 days. He was sent to the Naval Hospital, Brooklyn, N. Y., Sept. 28, 1923, for observation. He remained there until Oct. 5, 1923. His lung re-expanded completely and clinically he made a complete recovery. Pulmonary tuberculosis was not found. Physical examination Sept. 26, 1923, one day after onset showed, the patient pale and exhausted; he walked slowly and favored his left side. Temperature and pulse were normal; respiration rate, 20 per minute. There was lagging of the left side of the chest. Diminished fremitus was elicited over the upper half of the left chest. There was hyperresonance over the left lung. Diminished breath and voice sounds were noted over the entire left lung. The heart showed no displacement at this examination, although the patient stated that at Bellevue Hospital, the day before, fluoroscopic examination had shown the heart displaced to the right. X-ray examination on Sept. 26, 1923 (Fig. 4), revealed an area of diminished density and absence of lung markings extending along the major portion of the left chest. The margin of the lung was not so well defined as in Case 1. There was no evidence of any shifting of the mediastinum. There was a slight obliteration of the right costophrenic angle, probably due to an old pleurisy. Roentgenologic examination on Nov. 10, 1923 (Fig. 4), showed complete re-expansion of the left lung with no evidence of pulmonary pathology other than the slight pleurisy at the right base. The diagnosis was: non-tuberculous, fairly complete, spontaneous pneumothorax of the left chest, with complete recovery.

To date this patient is well, and during the past ten years, close check has failed to reveal any symptoms of lung disease. He is a lawyer in active practice in New York City.

Case 3. Male, 25 years of age, occupation, physician. His previous medical history was negative except for a slight pulmonary hemorrhage two years previously.

The onset of the spontaneous pneumothorax was on Oct. 22, 1923. It came on suddenly, when the patient stepped on a tennis court and before any play was begun, with sharp agonizing pain in the upper right chest and shoulder and shortness of breath. He was completely incapacitated for about fifteen minutes. The severity of the pain subsided gradually. The symptoms cleared up in four days. During this time the patient felt fairly comfortable, was up and about, and, except for some pain in the right side, had no other symptoms.

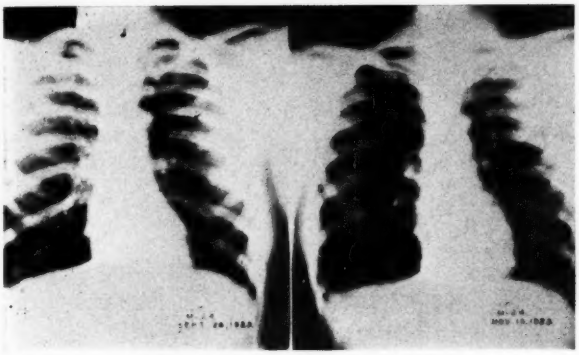

Fig. 4-*A*. Case 2. Partial left pneumothorax without mediastinal shift.
Fig. 4-*B*. Complete re-expansion of left lung.

Physical examination Oct. 22, 1923, disclosed lagging of the right chest, with diminished fremitus and hyperresonance over the upper half of the right lung, front and back. Breath and voice sounds were diminished over the entire lung. On Oct. 29, 1923, the physical signs were more marked, the lagging more pronounced, and the breath and voice sounds were completely absent over the entire right lung. The pneumothorax, which was partial on Oct. 22, 1923, had apparently extended and become complete. X-ray examination, Oct. 22, 1923 (Fig. 5), revealed a well-defined area of pneumothorax involving the outer half of the upper right chest and the axillary costal portion of the lower right chest. There were also well-defined areas of calcification at both apices and first intercostal spaces. The mediastinum was shifted slightly to the left. Roentgenographic examination, Oct. 29, 1923 (Fig. 6), showed an extension of the process causing complete pneumothorax on the right side with lung collapse. The final film taken Dec. 15, 1923 (Fig. 6), showed complete re-expansion of the right lung, with apparently no extension of the tuberculous process at the apices.

Clinically, this patient showed no evidence of tuberculous activity, as he carried on without any difficulty and was symptom-free. The diagnosis was: spontaneous pneumothorax right side, partial, later becoming complete; healed apical tuberculosis.

Case 4. Observed by the author (D. E. E.). Male infant, 11 months of age, admitted March 12, 1922, to Willard Parker Hospital, with a diagnosis of lobar pneumonia.

The physical signs were those of consolidation of the entire left lung with a suggestion of fluid in the left chest. X-ray examination, March 23, 1922 (Fig. 7), revealed consolidation of the entire left lung, with a complete spontaneous pneumothorax of the left pleural cavity. Another roentgenogram, taken March 30, 1922 (Fig. 8), showed a stage of resolution in

the solidified lung, with apparently no change in the extent of the pneumothorax. Aspiration of air was decided upon, but the infant died the following day. Consent was not given for a necropsy.

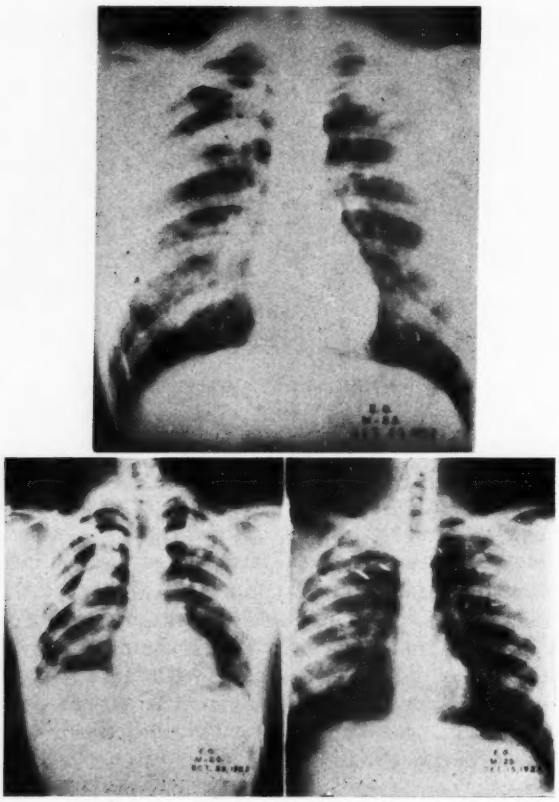

Fig. 5 (*top*). Case 3. Pneumothorax in right chest chiefly in upper part and base.
Fig. 6-*A* (*bottom*). Case 3. Increase of pneumothorax, one week later.
Fig. 6-*B*. Complete re-expansion of right lung with old tuberculous changes, seven weeks later.

Case 5. This case is one of spontaneous pneumothorax, recurring three times in the same lung, at intervals of about two years with complete re-expansion each time. The condition is non-tuberculous.

This patient was 40 years of age at the time of his first attack. His occupation was that of a silk merchant. He was observed by the author (A. S.) during the second and third attacks.

The previous history was that he had had an attack of spontaneous pneumothorax while crossing the Atlantic in June, 1925. He also had a chronic cough, which was diagnosed as chronic bronchitis.

On the morning of June 27, 1928, he woke up with severe pain in the left side of chest and dyspnea. Suspecting a recurrence of an attack similar to the one of two years before, he called A. S. within one-half hour of inception of his pain. The patient was in bed, was pale and moderately dyspneic. He seemed to splint his left side. His temperature was 98, pulse 88. There were marked lagging,

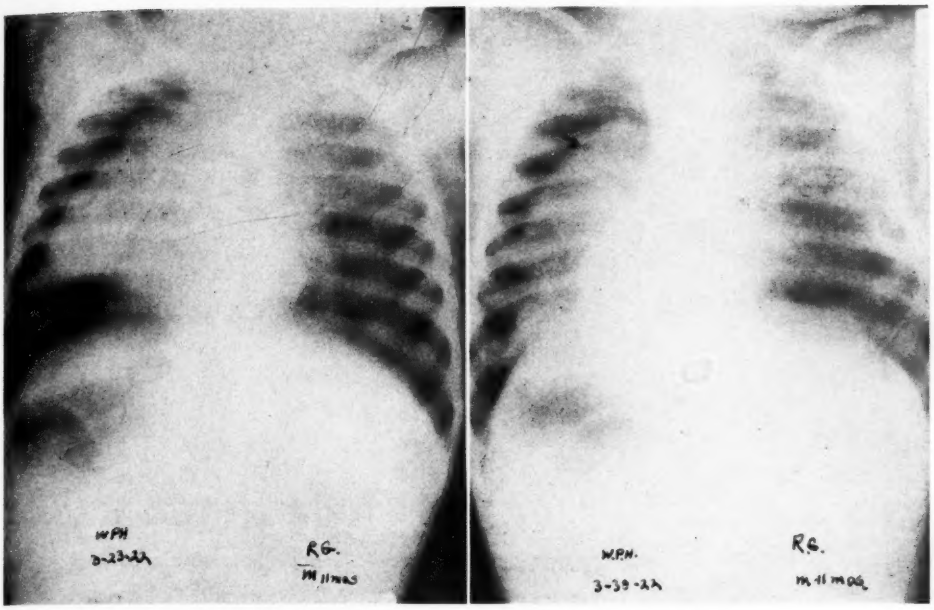

Fig. 7 (*left*). Case 4. Consolidation of entire left chest with complete pneumothorax.
Fig. 8 (*right*). Case 4. One week later resolution in solidified lung with no change in the pneumothorax.

diminished fremitus, hyperresonance and absent breath sounds over the left lung. The apex beat of the heart was pushed 2 or 2.5 inches to the right. The right lung showed harsh breathing with a few scattered sibilant râles. X-ray and fluoroscopic examinations the following day showed a complete left-sided spontaneous pneumothorax, with moderate displacement of the heart and mediastinum (Fig. 9).

Re-expansion and clinical convalescence were slow. It took two months for complete recovery. During this observation period there were no symptoms or signs of tuberculosis. The treatment was symptomatic, including a one-month sojourn in the mountains.

On Feb. 1, 1930, while taking a shower, he experienced a similar attack of pain. The history of this attack varied but little from the other two. The physical and clinical findings were similar. X-ray examination at this time showed a three-quarters collapse, with definite evidence of thickening of the left pleura and a wide pleural adhesive band extending from the hilum of the lung. There was no evidence of pulmonary tuberculosis. Following this episode he was under my observation, reporting regularly once a month. He has remained in fairly good health to date, aside from an asthmatic-bronchitic condition which is of long standing.

Case 6. This is a case in which re-expansion of the lung failed to take place. This patient is a man, 49 years of age, in the bonding business. He has had three attacks of pleuro-pneumonia in the previous ten years, with a chronic cough and wheezing in the chest for many years. No history of tuberculosis was elicited.

On Oct. 17, 1930, while walking, he was suddenly seized with a sharp, lancinating pain in the left chest, with marked shortness of breath. He collapsed and was taken to Bellevue Hospital by ambulance. He remained there 15 days, receiving symptomatic treatment only.

Physical examinarion on Nov. 2, 1930,

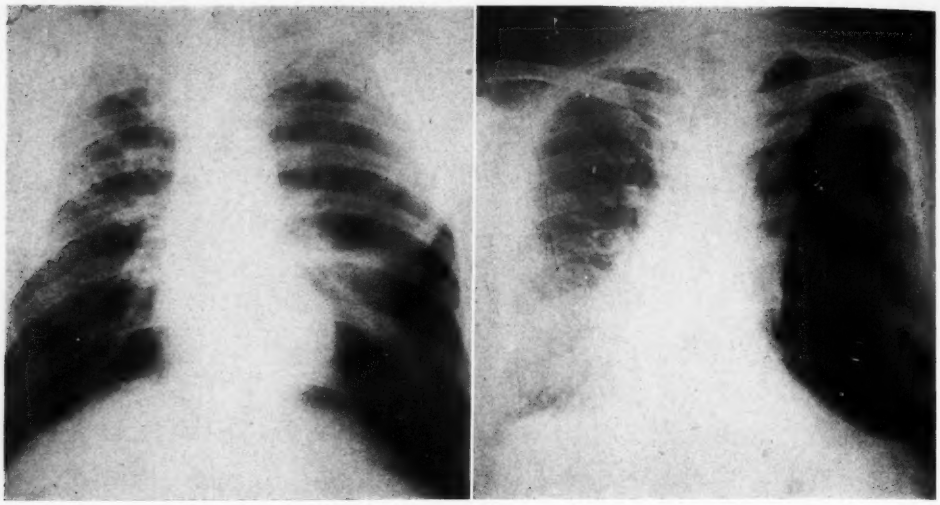

Fig. 9 (*left*). Case 5. Complete left pneumothorax with mediastinal deviation.
Fig. 10 (*right*). Case 6. Complete left pneumothorax with mediastinal deviation to the right.

showed hyperresonance with absent breath sounds over the left lung. The heart showed signs of being pushed to the right. The right lung had scattered, sibilant, and musical râles with medium, moist râles in the axillary area of the base. X-ray examination corroborated the physical signs of complete spontaneous pneumothorax of the left chest, with displacement of the heart and mediastinum to the right. A thick, adhesive band was noted binding down the left lung (Fig. 10).

The same physical signs and fluoroscopic findings are present to date. Clinically, the man remains well-nourished and looks quite well. He is moderately dyspneic and has a chronic cough, but attends to business daily. I (A. S.) see him regularly once a month and keep on telling him that one of these fine days we will go in, cut the adhesion binding his left lung, and possibly cause it to re-expand.

Case 7. Male, 30 years of age, sign painter, was seen by D. E. E. in consultation at the Health Department, Mott Haven Tuberculosis Clinic, Bronx. Admitted Oct. 29, 1935, from Bronx city hospital where he had been from July 28, 1935, to Oct. 1, 1935. Diagnosed as a case of left pleural effusion with pulmonary tuberculosis. Numerous examinations of the sputum done and no tubercle bacilli were found. Guinea pig inoculation of chest fluid proven negative. Numerous x-ray examinations show thickened pleura with a slight amount of fluid at the base and partial pneumothorax. The upper and lower lobes were partly collapsed. A large cavity was noted in the lower part of the collapsed lobe. Diagnosis on admission to the Clinic was chronic pulmonary tuberculosis (2-A). At time of admission to the hospital, the patient complained of high temperature and profuse perspiration of one week's duration, slight cough, scanty expectoration, no hemorrhage, occasional dyspnea on exertion, pain in left side and back. Previous history of measles and whooping cough in childhood.

At the Health Department Clinic numerous physical examinations were made Dec. 9, 1935, and March 16, 1936, showing at first a re-expanding pneumothorax in the left chest; April 13, 1936, diminished breath sounds over the left upper lung. Jan. 14, 1937, physical examination negative.

Sputum examination on six separate

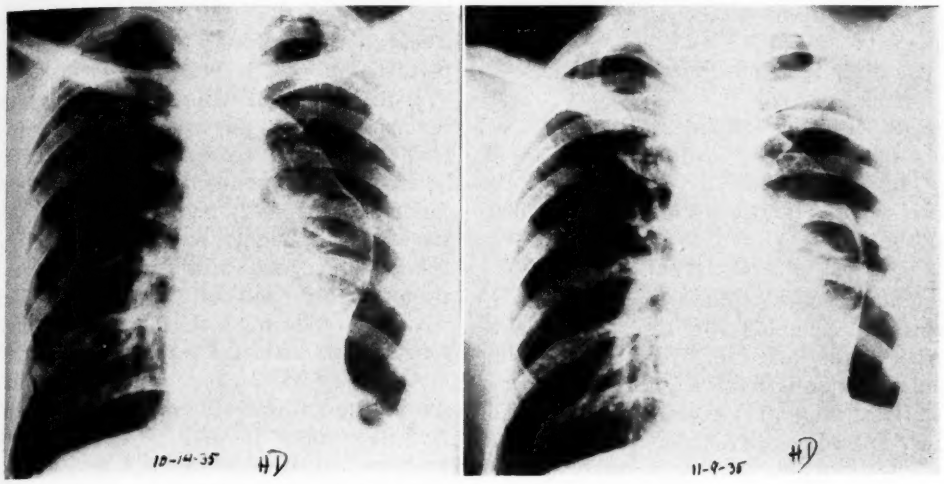

Fig. 11 (*left*). Case 7. Complete left pneumothorax with large emphysematous bleb directly adjacent to it and irregularity of visceral pleural margin overlying emphysematous bleb.
Fig. 12 (*right*). Case 7. Ten weeks later. Pneumothorax slightly diminished; pleural irregularity absent.

studies with a concentrated sputum all proved to be negative. X-ray examination Oct. 14, 1935 (Fig. 11), showed a partial left pneumothorax with fluid in the lower portion of the chest. Dec. 9, 1935 (Fig. 12), there is some re-expansion of the collapsed lung with a rise in the level of the fluid. A large, oval area of rarefaction is visualized in the mid-lung field just beneath the visceral pleura. The appearance is very suggestive of an emphysematous bleb. Jan. 20, 1936, the left lung is re-expanding. There is thickening of the visceral pleura and fluid at the base. The lung re-expansion has increased, the mediastinum is not shifted. The right lung appears clear. March 16, 1936, no change. Aug. 11, 1936, the left chest shows slight clouding at the base which is less than previously and due to thickened pleura. The lung-fields are otherwise negative. Nov. 2, 1936, left basal pleuritic thickening and slight displacement of the mediastinum to the left; chest is otherwise negative. Feb. 25, 1937 (Fig. 13), mediastinum still shows a slight shift to the left. The left costophrenic sinus is clouded. In the mid-portion of the left fourth and fifth interspaces there is noted an irregular lung translucency which outlines to a much less degree and extent the bleb formation that was so well made out in the original films with the pneumothorax.

During the entire observation of the patient in the Health Department Clinic he had no complaints, feeling perfectly well.

Jan 4, 1937—Mantoux test—0.1 mgm. 1 plus (?)

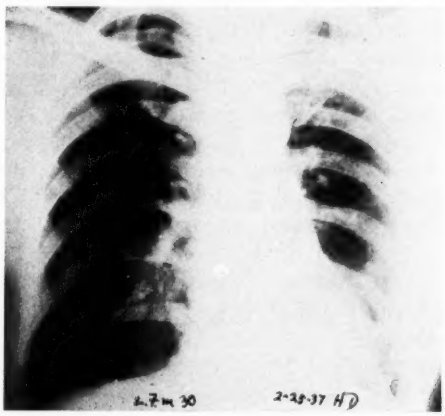

Fig. 13. Case 7. Pneumothorax disappeared. The emphysematous bleb is present but not clearly delineated.

Feb. 20, 1937—Mantoux test—1 mgm. neg.

Oct. 29, 1935—Sedimentation Index—6 mm.

Dec. 9, 1935—Sedimentation Index—2 mm.

This case beautifully demonstrates the bleb as the etiological factor of the pneumothorax.

REVIEW OF LITERATURE

Osler (1) states that 90 per cent of spontaneous pneumothorax cases are due to tuberculosis, according to S. West; that the condition is extremely rare, and that it is almost invariably associated with fluid or pus. Another point Osler makes mention of is that pneumothorax rarely follows fracture of a rib, even though the lung may be torn. He cites one case of pneumothorax developing in a patient of his while going downstairs. No effusion followed and the patient did not react to tuberculin.

Louis Hannon (2) reports five cases, three of which were non-tuberculous as proved by one, three, and five years' follow-up. However, he regards all cases as definitely tuberculous, and due to the rupture of a pleural adhesion into a small peripheral tuberculous focus, closure of which follows lung collapse.

I. S. Kahn (3) reports a case of idiopathic spontaneous pneumothorax, non-tuberculous. There was a history of asthma, lasting 18 years. The complication occurred while lifting an 80-pound sack of beans, the patient being seized with a sudden discomfort and tightness in the left chest. Cough was a prominent symptom. There was no tendency to re-expansion after nine weeks, so that aspiration of air had to be resorted to. The lung re-expanded completely within a few weeks, following thoracentesis.

F. P. Weber (4) in discussing spontaneous pneumothorax, states that there are practically 200 cases on record in which this accident has occurred in apparently healthy persons, without obvious exciting cause beyond sudden respiratory effort.

Terry (5) reports a case of spontaneous pneumothorax of uncertain etiology that had occurred in a young man while taking a cold shower. Return to normal was complete in four weeks.

J. B. Hawes (6) reports a case of recurrent spontaneous pneumothorax occurring first on one and then on the other side, both apparently non-tuberculous.

Alfred Meyer (7) reports a case of bilateral spontaneous pneumothorax, non-tuberculous, with autopsy, showing extreme emphysema of both lungs. The patient died during a third attack; all had taken place within a period of one year.

A. S. Hendrie (8) reports a case of traumatic spontaneous pneumothorax occurring in a young football player, following pressure on the chest in a scrimmage. There was another attack, on the opposite side, one week later, during another game.

Leon T. LeWald (9) reports a case of spontaneous pneumothorax in a messenger boy 16 years of age, while running an errand. He collapsed in the street suddenly, complaining of pain in the right chest and was taken to a hospital, remaining there one day. Diagnosis was unsolved until three weeks later, when a roentgenogram revealed the true nature of his condition. No evidence of active or latent tuberculosis was found, and no history of previous illness. The chest was deflated. Complete expansion of the lung followed in 11 days. LeWald says that in not a single case out of a series of more than 10 cases has there been any evidence of tuberculosis. Seven made prompt recoveries. Two showed persistent pneumothorax. He concludes that spontaneous pneumothorax may occur in a person with healthy lungs and result in complete and permanent recovery.

M. R. Castex and E. S. Mazzer (10) say that recurrent benign spontaneous pneumothorax is a result of the tearing of the so-called subpleural blebs, the rupture of which is caused by an exaggerated pressure during an effort. The subpleural blebs form themselves mechanically, at the level of the weaker or slightly altered areas of the lung at the time of gaseous overdistention at that level.

A. Schick (11) states that Schminker and Kjaegrood hold congenital pulmonary cysts as etiological factors. The rupture of a superficially located cyst gives rise to the pneumothorax. They regard these cysts as developmental congenital anomalies of pulmonary alveoli. The author was able to demonstrate one case clinically and roentgenologically from the clinic of Julius Bauer, of Vienna, of a cyst as the case of idiopathic spontaneous pneumothorax.

The Editor of "Queries and Minor Notes," Journal of American Medical Association (12), makes the following statements: "The most common cause of spontaneous idiopathic pneumothorax is the rupture of an emphysematous vesicle. These vesicles depend on scar tissue involving a bronchiole in such a manner as to produce expiratory obstruction. There results gradual overinflation of the affected lobule with ultimate perforation into the pleural cavity."

L. K. Sycamore (13) reports a case of recurrent idiopathic spontaneous pneumothorax of the relapsing type with a pronounced tension pneumothorax in one attack. The emphysematous bulla, which was apparently the etiologic factor, was plainly visible on the roentgenogram.

SUMMARY

1. The cases here reported constitute an interesting variety of spontaneous pneumothorax, namely, one idiopathic case; two occurring in the presence of latent minimal tuberculosis, but in otherwise healthy individuals, with no activity following re-expansion of lungs; two secondary to chronic adhesive pleurisy and asthmatic bronchitis; one in an infant complicating lobar pneumonia and one case resulting from an emphysematous bleb demonstrated roentgenologically. One of the series showed three occurrences, two years apart, with complete re-expansion each time; one failed to re-expand seven years following collapse.

2. Spontaneous pneumothorax, essential, without demonstrable antecedent pulmonary or pleural pathology, is comparatively rare, but that it does occur with greater frequency is no longer doubtful.

3. A plausible theory for the possibility of such an accidental occurrence in a healthy individual with healthy lungs is offered by the authors.

4. Sudden sharp pain accompanied by a choking sensation in one side of the chest are the invariable symptoms; dyspnea is present to a greater or lesser degree, while cough is not a prominent symptom.

5. Fluoroscopy alone is not sufficient to exclude a partial spontaneous pneumothorax. In a suspicious case, roentgenograms during both phases of respiration are necessary. Progress can be definitely checked by serial x-ray examinations.

6. Cases of spontaneous pneumothorax, idiopathic, or those secondary to slight pleural or pulmonary pathology, including healed cases of tuberculosis, all tend to recovery.

7. Treatment is essentially symptomatic. If respiratory distress is pronounced, deflation is resorted to.

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RACIAL VARIATIONS IN THE INCIDENCE OF CANCER[1]

By SIR G. LENTHAL CHEATLE, *London, and* MAX CUTLER, M.D., *Chicago*

THE study of the racial incidence of this disease creates an enormous interest in the clinical side of the investigation into the processes of cancer. To such an extent is this interest stimulated that it rivals the importance of laboratory experiments. Moreover, the possibility of preventing the disease looms large in the study of its racial incidence.

The whole question of racial incidence is crying out for general, specific, and more detailed investigation. In Great Britain alone, for example, although the general incidence of cancer is fairly well estimated, there are still gaps in our information concerning Scotland, Ireland, and Wales; in England itself there are races of different descent.

Besides an inquiry into the racial relation of a cancer patient, the reports of the racial incidence of cancer would be enhanced if the family history in relation to cancer were included in the report of each individual. The question of the importance of the family history of each patient has been raised by Waaler, of Norway. With great care, determination, and accuracy he has conducted an inquiry into the family histories of sisters suffering from cancer. He proved the hereditary influence to his own satisfaction in 30 per cent in some districts and in 70 per cent in others.

A combination of racial and individual family histories of every person suffering from cancer would be highly instructive and would add to the value of racial connections. One of us (G. L. C.) tried in London in a very humble way to elicit family histories in his cases of cancer of the breast. In going into the matter, he found that he would require a staff of tactful and skillful inquirers of such large and expensive proportions that the investigation by a single person, for this and many other reasons with which we need not trouble this meeting, was rendered out of the question.

In the time and space allotted to us, and for lack of specific information, it is impossible to make our survey as complete as it will be at some future time. For example, a racial survey of cancer in Great Britain cannot be complete until the incidence of the disease can be observed in Ireland, Scotland, Wales, and England. In some parts of England the races can be traced back to Saxons, Danes, and Normans. In America, races are very mixed in places and in others they are segregated. Obviously, the racial incidence of cancer would be purer in the areas where races are segregated than in those parts where the races are mixed. Although Jews live in areas where they are mixed with Gentiles, they remain a fairly pure race. Their family histories, therefore, would be of importance in any country. It would be interesting to discover whether their environments in the different countries in which they live make any difference in the incidence of cancer among them.

There are, however, some interesting facts which emerge from the study of the racial incidence of cancer. The coolies in Sumatra, for example, are either Javanese or Chinese—both live under similar social and climatic conditions and do not intermarry. It has been found that the total mortality from cancer among the coolies is about as high as among corresponding age groups in Holland, and it is not very different for Javanese and Chinese. The organ incidence, however, shows extraordinary variations. The most frequent form of cancer among the coolies is a primary liver-cell cancer (not bile duct cancer), which is almost always associated with cirrhosis of the liver, a type of cancer which is extremely rare among Europeans. Next in frequency among the Chinese is

[1] Presented before the Fifth International Congress of Radiology, in Chicago, Sept. 13–17, 1937.

cancer of the stomach—very rare in the Javanese. In passing, it is interesting to note that gastric ulcer also is frequent in the Chinese but rare in the Javanese.

In certain parts of the world, notably in the south of France, cancer of the skin is the most frequent form of cancer; Dr. Ducuing believes it constitutes 60 to 70 per cent of all malignant disease. The incidence of cancer of the skin is also high in Australia.

In these instances there appear to be two conditions in operation: (1) *The external factor*, such as irritation from a carcinogenic substance; (2) the susceptibility of races or individuals. More investigation is needed on these points. The same conditions apply to the following statement: The proportion of the number of cancers to the population is the same in Great Britain, Japan, Switzerland, and Holland, but the sites of cancer incidence vary in the different countries named. This appears to be a statistical law for cancer. (See Cramer's comparison between Holland and England.)

In all these countries the males suffer chiefly from cancer of the digestive tract, while the females do not suffer to the same degree from cancer of the digestive tract but the proportion of cancer in them is brought to a level with the males by the addition of cancer of the breast and uterus. The proportion of cancer of the breast and uterus also varies in the different countries. Cancer of the breast in Japan is small compared with cancer of the breast in England, Holland, and Switzerland.

In an analysis of the mortality from gastric cancer in countries with a high incidence of gastric cancer arranged according to social status or professions, it is found that cancer of the stomach is more frequent in rural than in urban populations. An analysis of the incidence of cancer of the stomach was made by Dr. Stevenson ten years ago, when he divided the population of England into five social classes. His study showed that the incidence of cancer in the upper digestive tract increases rapidly as we descend in the social scale, while the incidence is almost the same in all social classes for the lower part of the digestive tract.

Dr. Cramer comments as follows upon these facts: "This argument proves, to my mind conclusively, that the stomach—and upper part of the digestive tract—is exposed in certain social classes to conditions which lead to cancer, but which are avoided to a large extent by the upper social classes." He further comments that cancer of the stomach in the lower classes can be avoided and prevented by studying the habits and conditions of life of those groups of population where it is very prevalent.

Flude, of the American Society for the Control of Cancer, who has studied the cancer problem in the Territory of Hawaii, finds that the cancer death rate is considerably below the average for many other civilized countries. As regards racial incidence, the most important fact is the enormous toll this disease takes among the native Hawaiians.

The most significant finding, however, is the remarkably low incidence of cancer of the breast among the Japanese, who constitute 38 per cent of the population. During the period from 1930 to 1934 the incidence of cancer of the breast was 10 per cent among the Caucasians, 9 per cent among the Hawaiians, and only 1.8 per cent among the Japanese.

This finding confirms the general impressions that have prevailed on this subject. One of us (M. C.) has discussed this question with many of the Island physicians who have been engaged in the practice of medicine for many years. The comment is freely made that whereas they encounter cancer of the breast among all the races, they find difficulty in recalling a single instance of this disease among the Japanese, although this race constitutes a definite majority in population (37 per cent).

Confronted with these remarkable facts, one of us (M. C.) took the opportunity to study this question in Japan. In a comprehensive monograph dealing with sta-

tistical studies of cancer in Japan, Nagayo comments upon the subject of mammary cancer in Japan as follows:

"In clinical statistics mammary cancer ranks fourth in both sexes combined (4.69 per cent). In the female it ranks third, being preceded by uterine and gastric cancers, being about three times as frequent as rectal cancer which ranks fourth. This shows that mammary cancer is not rare in Japan.

"In statistics based on autopsy material, we find in the female that in the early period of our pathological institute, mammary cancer ranks tenth with 3.27 per cent, in the later period sixth with 4.33 per cent, and in the total eighth with 3.78 per cent. It is thus ranking below the cancers of stomach, uterus, gall bladder, lung, ovary, liver, and rectum. This relative scarcity of mammary cancer is explainable by the small number of autopsy cases coming from surgical clinics and also by the fact that complete cures result in some cases from treatment, especially from operation at a suitable period.

"As stated above, in vital statistics as well as in autopsy statistics, mammary cancer is not abundant, but it seems safe to say that this form of cancer is not necessarily scarce in clinical material. Thus, we find that patients with mammary cancer are not few in number in Japan, but the frequency in Japan is considerably less than in such countries as England or the United States where mammary cancer is especially abundant. In England, mammary cancer is more abundant than uterine or gastric cancer and in the United States it ranks second, next to uterine cancer. In comparison to these countries, there is a far less number of mammary cancers in Japan."

There is a considerable difference in the death rate in females from mammary cancer among different countries. According to Hoffman, the countries showing the highest rates are England and Wales, 19.1 and 17.8 per cent, respectively; the Philippine Islands 14.0 per cent, while in Chile the rate is 2 per cent, in Egypt 6 per cent, in Hawaii 6 per cent, in Spain 7 per cent, and in Ceylon 7.6 per cent. Japan's rate is given as 3 per cent. These figures are all based on vital statistics and it must be remembered that patients are actually more numerous than these figures indicate.

Nagayo suggests that the relative infrequency of mammary cancer in Japan and its comparative abundance in Europe and America may be connected with the habits of Japanese women of suckling their infants for long periods. From a study of the mortality statistics in Japan and Hawaii it is evident that the incidence of mammary cancer among the Japanese is low in both countries as compared to its incidence in Western countries. Also, the incidence of the disease among the Japanese women in Hawaii is less than among the Japanese in Japan—1.8 per cent as compared to 3.4 per cent. Both of these figures are based on vital statistics. The autopsy statistics given by Nagayo for mammary cancer agree closely with the vital statistics (3.7 per cent autopsy, 3.4 per cent vital).

It is a remarkable fact that whereas uterine cancer is only slightly more frequent in Japan than in England and Wales, mammary cancer is one-tenth as frequent as uterine cancer in Japan; while in England and Wales mammary cancer is more frequent than uterine cancer. Such overwhelming differences cannot be merely superficial variations: they must be real and must have an underlying reason. The great question arises as to whether the differences are racial, familial, or due to extrinsic factors.

Other highly interesting differences in the incidence of various forms of cancer in the Far East may be mentioned here. There is a remarkably high incidence of primary liver cancer in association with cirrhosis of the liver. There is almost a total absence of gastric cancer among the native Malay population of Java, associated with a similar scarcity of gastric ulcer, although the Chinese in Java and in the tropical parts of the Far East show the usual incidence of these diseases (Bonne).

The high incidence of esophageal cancer among the Chinese farmers as compared to its low incidence among the city dwellers is of interest in relation to the drinking habits of the two groups. The Chinese farmer drinks a strong beverage, similar to vodka,

called *pai-kan*, whereas the city dweller drinks mild rice wine.

The relative frequency of esophageal cancer among Japanese men and its possible relation to the consumption of hot Japanese saki has been noted by Nagayo.

SUMMARY

Statistical comparisons of cancer mortality among the different races may be a source of important information upon the remote causes of cancer.

A study of cancer statistics among different races indicates little difference in racial susceptibility to cancer generally, but marked differences in the incidence of cancer of different organs in the various races.

The important question that remains to be answered is whether these differences are due to racial susceptibility, individual susceptibility, or to external factors that are determined by habits and customs. The evidence would seem to favor the view that individual susceptibility may be a more important factor than racial susceptibility. The extent to which these remarkable differences are due to intrinsic factors or to extrinsic factors is a problem for further study and investigation.

CLINICAL OBSERVATIONS IN THE TREATMENT OF CANCER BY SUPERVOLTAGE X-RAYS[1]

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THEORETICAL considerations make it reasonable to expect that supervoltage x-rays provide a much greater depth dose than is obtained by the use of 200 kv. x-rays (at from 50 to 70 cm. T.S.D.) or by the radium bomb as employed therapeutically at a much shorter distance from the skin (6 to 10 cm.).

The initial outlay for supervoltage equipment is approximately five times that of 200 kv. apparatus, and consequently therapy costs, r for r, are higher than with 200 kv. However, supervoltage has four (and possibly five) advantages over 200 kv. in the treatment of deep-seated lesions:

(1) Increase of skin tolerance—based on the dosage measured with a standard air chamber.
(2) Greater penetration of the beam itself—providing intrinsically a greater depth dose at ten or more centimeters.
(3) Relative independence of depth dose on portal dimensions, thus permitting the selection of multiple therapeutic fields of just sufficient size to include the volume to be irradiated. The skin area in this way can be used to greater advantage and irradiation of tissues and organs adjacent to the tumor minimized.
(4) The more uniform distribution of radiation at 10 cm. depth.
(5) The possible existence, suggested by some workers, of a biological advantage due to wave length.

Considering both treatment and equipment costs, 200 kv. is extremely practical. Treatment can be had at moderate cost and present-day equipment, providing high intensities, is mechanically very satisfactory and this type of radiation is much more effectively employed to-day than five or ten years ago. It would be a serious economic waste if 200 kv. equipment were replaced, even in part, by supervoltage equipment unless the latter is judged by clinical performance to be far superior. It is a comparatively new modality with which to combat cancer, and its appropriate use and limitations are still being investigated.

There are only a few centers in the world where a radium bomb is available. Under the existing limitations of intensity, treatment time is prolonged and in consequence the number of patients who can receive therapy of this type is relatively small. Moreover, the high price of the bomb makes treatment very expensive. If unquestioned advantage is finally attributed to the very short wave lengths characteristic of radium bomb treatment, then a quite comparable quality of radiation can be obtained by building x-ray equipment to operate at higher voltages than are now used. Supervoltage has four advantages over the radium bomb as it is commonly employed in therapy: (1) greater depth dose; (2) much greater intensity; (3) far more flexibility, since the size of the field and the rate of treatment can be varied within wide limits; (4) lower cost of treatment because supervoltage tubes can be constructed for only one-fourth to one-fifth of the cost of the five-gram radium bomb, and because these tubes can be designed to treat from two to four patients simultaneously.

The first x-ray equipment to be operated at potentials over 300 kv. was constructed in 1928 by Lauritsen (1,2) and his

[1] Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13–17, 1938.

associates at the California Institute of Technology, in Pasadena. In the latter part of 1930 a clinical study was begun to determine the effect of very penetrating x-rays on inoperable carcinoma. From the outset we have been interested, not in justifying the use of supervoltage equipment, but in observing its effects on malignant lesions, recognizing that final judgment must be based on therapeutic results.

At the W. K. Kellogg Laboratory, 746 patients with inoperable malignant lesions have been treated since October, 1930. During the last five years we have, in the main, limited our work to deep-seated lesions of the prostate, rectum, bladder, esophagus, kidney, and to advanced carcinoma of the cervix: we have also irradiated cancer of the pharynx, larynx, breast, and testicle. With very rare exceptions, diagnoses were confirmed by biopsy. In the cases with fatal termination 80 per cent of autopsies have been obtained and this has been of great importance to an understanding of results.

At the time we started our work, no therapy with supervoltage had been attempted, and it was, therefore, considered desirable to proceed very cautiously, closely observing the effect on the patient's general condition, the skin, the subcutaneous tissues, irradiated organs, and adjacent structures as well as on the lesion itself. During the first two years the large majority of patients accepted had very advanced lesions and in many instances these patients had previously received unsuccessful treatment with radium, x-rays, or both. Small cycles of treatment were administered at intervals. Only a few of these patients are now living, but the observations made during their lifetimes and the findings at autopsy indicated to us that in all probability the doses used had been inadequate and that higher doses and increased treatment rate should be tried.

In order to reach a high total depth dose in supervoltage treatment it is necessary to employ field sizes which will include the entire tumor and to cross-fire this region from as many fields as can be satisfactorily utilized on the skin. Our present treatment factors are 900 kv., 3 ma., 6 mm. steel plus 1 mm. lead filter, 58 cm. target-skin distance, intensity 15 r per minute as measured by a standard air chamber. This quality of radiation is characterized by a half value layer of 6.5 cm. of water or 8.1 mm. of copper.

Up to October, 1936, 161 cases of carcinoma of the cervix have been irradiated, 93 per cent of these patients being classified in Groups III and IV (Schmitz) or as victims of post-operative recurrence All cases were accepted for treatment if they were not terminally cachectic, if they showed no definite evidence of distant metastases, and if there was no gross ulceration of the bladder wall. Many of these patients had far advanced cancer, but were taken for whatever palliation could be achieved. Preferably a single cycle of treatment was given through from six to eight 10 × 15 cm. portals and usually at a daily treatment rate of 300 r over one field. The total dose varied between 10,000 and 20,000 r as measured in air. Individualization of the treatment plan in each case is required and depends not only on the patient's general condition, but also on the skin effect and on the reaction of the organs and tissues immediately adjacent to the tumor. With this method we have rarely seen dangerous complications or serious sequelæ. In a small group of patients, with the hope of improving our results, a treatment technic which provided a higher total dose and a greater daily intensity was employed. However, we do not feel that such intensive treatment is warranted since we have seen irreparable damage to the bladder and rectal mucosa, even though there was no striking cutaneous reaction. The primary regression in mid- and late-stage cervical carcinoma has been very encouraging. All of the post-operative cases and roughly half of our other cervix patients have been treated by supervoltage x-rays alone, the balance by supervoltage supplemented

with radium. However, in general we prefer the combined method. Of 42 patients in Group III, 19 (45 per cent) are alive with no definite evidence of disease; out of 86 in Group IV, 18 (21 per cent) are living and apparently well, and of 22 post-operative recurrences, six (27.1 per cent) are clinically free of disease. Our patients post-date treatment from one to four years. These results include 25 Stage III and Stage IV (Schmitz) cases with a residual fibrosis of the broad ligaments which after repeated pelvic examinations, over at least a year's time, reveal no definite evidence of malignancy. It is only too clear that the follow-up period is inadequate and that a number of recurrences are to be expected. These data are included as an interim report for the purpose of indicating the immediate effects of supervoltage irradiation. Radiation sickness is uncommon but if the patient's general condition is poor at the start, treatment is not well tolerated. Maintenance of a patient's weight is important. Watery diarrhea and mild cystitis are frequently noted at the conclusion of the pelvic cycle. While during treatment many of these patients develop a marked erythema, with or without vesiculation in the perineum and in the intergluteal fold, the cutaneous reaction subsides within a few weeks without noteworthy sequelæ. Contraction of the upper vagina and telangiectasia over the cervical mucosa are occasionally seen. Cystoscopic examination in a few patients several months after a pelvic cycle has shown moderate telangiectasia and contraction of the bladder mucosa.

By the use of two small ionization chambers we have determined what we believe to be the most serviceable portals in teleradiation for cervical carcinoma. One of the ionization chambers is placed at the center of the portal of entry of the beam and the other within the posterior vaginal fornix. By this means it is also possible to make sure that patients are properly set up for treatment. Of course, the ionization chamber readings vary in patients of different weights and physical habitus. In a woman 5 feet 4 inches in height, weighing 140 pounds, the intensity in the posterior vagina was 38 per cent of the dose applied to the anterior pubic field, 48 per cent of the dose over the perineal portal, 48 per cent of the dose at the coccygeal field, and 38 per cent of the dose applied over the sacral portal. Four 10 × 15 cm. fields were used, the longer dimension across the pelvis. When 10 × 10 or 10 × 15 cm. lateral portals were used the intensity in the posterior fornix was 25 per cent.

Up to October, 1936, 104 cases of proven carcinoma of the prostate have been irradiated. In a large number of these, there has been regression of the local lesion. The prostate becomes softer, smaller, and less nodular; occasionally the nodules disappear. In these lesions regression takes place slowly and it is sometimes a number of months before any improvement is noted. The general condition of the patient has usually remained satisfactory under treatment, but if troublesome cystitis develops we have found it desirable to discontinue treatment for several weeks. Under these circumstances it is then frequently possible, and occasionally desirable, to administer a second cycle of treatment. Since most of these patients have had transurethral resection with relief of urinary obstruction prior to treatment, and since it is well known that unirradiated carcinoma of the prostate is a disease which sometimes progresses slowly, the palliation achieved is difficult to evaluate. However, in our group of cases there has been a change of trend in this disease since noteworthy regression of the local lesion has taken place in over half of all the persons treated. Again as an interim report it may be of interest to note that 38 (36 per cent) of our patients are living, of whom 31 have been free of symptoms for periods varying from one to four years. In only a few cases has subsequent resection been necessary. Patients have died chiefly from metastases. In prostatic malignancy, as well as with cancer in other locations in the aged, it must be

borne in mind that the struggle against death is not concerned with carcinoma alone, for allied with death are all the forces which accompany senility.

In the main, results in bladder carcinoma have not been reassuring.

In rectal carcinoma also the results have been disappointing. In general, we have not observed much permanent benefit: in rare instances a fixed lesion has shown marked regression and has been rendered operable. In some cases worthwhile palliation was achieved, as evidenced by occasional reduction of growth and cessation of hemorrhage.

Renal tumors have done well. In two out of six cases of Wilms' type, regression was so marked that nephrectomy was easily performed. These two patients are alive and well. Out of eight cases of post-operative hypernephroma in which tumor tissue remained in the renal vein, four show no evidence of malignancy following supervoltage therapy.

Palliation for varying periods of time has been observed in esophageal cases. Few patients in this group have survived more than one year, and none for two years.

In testicular cases we have irradiated not only the site of the primary tumor, but also the lymphatic channels through which the disease commonly spreads. Except in a few patients who had resistant lesions, the results have been encouraging, even though distant metastases were present in a few patients at the inception of treatment.

Our observations thus far in mid- and late stages of cancer of the breast lead us to believe that there is little or no additional advantage in supervoltage therapy as against adequate irradiation with 200 kv.

In the x-ray treatment of carcinoma of the larynx and pharynx, Coutard has pointed the way, and although quite comparable results in certain cases can be attained with supervoltage, it would seem that 200 kv. irradiation provides sufficient ionization in the tumor-bearing regions involved.

It is obvious that it is too early to draw final conclusions regarding supervoltage irradiation. Fortunately, therapy of this type is being carried on in a number of laboratories in this country and abroad. It is to be hoped that co-operation between these clinics will result in a better understanding of the proper use of this agent.

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SHARPNESS OF SHADOWS IN RADIOGRAPHY OF THE LUNGS

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ABSTRACT

The author discusses relationship of exposure time to sharpness of x-ray shadow and arrest of movement for radiography of the chest. He uses a new criterion of sharpness, namely, the visibility of the small pulmonary vessels (idealized). He gives relationship between permissible loadings on the focal spot to the degree of sharpness attainable. Unsharpness varies inversely with the cube root of tube loading (ma. per mm.^{2} apparent focal spot). X-ray tubes with stationary anode are incapable of resolving 0.5 mm. pulmonary vessels set 0.25 mm. apart and moving 5 mm. per second. With present apparatus the best arrest of lung detail moving 5 mm. per second is with 1 mm. focal spot on a rotating anode, $^1/_{40}$ sec., 200 ma. at 1 meter distance. To use 2 mm. focal spot, 500 ma., at 2 meters is almost as good, and might be preferred on account of better detail in bones and lesser magnification of heart shadow.

SOON after the Rotalix tube was developed, Bouwers (1) calculated the optimum exposure time to produce the sharpest shadow of a moving object. Warren (2) noted that the unsharpness due to finite size of focal spot and that due to movement are not simply additive as Bouwers had taken them, but that the observed unsharpness is less than the sum of geometric unsharpness and movement unsharpness. He has given graphs of observed unsharpness related to exposure times for two speeds of movement (5 mm. per sec. and 2.5 mm. per sec.) and for two permitted focal spot loadings (line focus on a stationary anode and on a rotating anode). And he gives his recommendations for technic in chest radiography based on these calculations.

Both of these authors have considered the shadow of a sharp edge. But fuzziness of a large shadow is not of much importance. Chantraine (3) has given a dictum, "A picture is to be taken as clearer than another if it shows smaller details," with which I agree. He made some experiments with rape seeds and concludes that for visibility on non-screen film an unsharpness of 0.2 mm. requires that the object be 11 per cent thicker, for 0.4 mm. unsharpness 23 per cent thicker, and for 0.8 mm. unsharpness 54 per cent thicker. He notes that the unsharpness of screens is so bad that there is hardly any advantage in going from 0.4 to 0.2 mm. unsharpness of shadow.

In the case of the lung, we are dealing with small vessels. Let us consider the shadow of a thin cylinder. The absorption is only a few per cent, so can be taken proportional to the thickness. The center of the shadow is denser than the edges. The profile of the shadow is (proportional to) a semicircle if we have no movement, and the focal spot is a point.

If we move the cylinder under a point focus, or if we hold the cylinder still and use a broad focus, the shadow will be degraded—and in the same way by either mechanism. The new profile can be calculated by summing the shadows cast by each portion (I used tenths) of the target face (or, for movement unsharpness, each portion of exposure time). We can designate these unsharpnesses by the total increase in width of the shadow.

Some preliminary trials convinced me that an astonishing amount of unsharpness is required to obliterate the shadow of a thin cylinder. It seemed promising to try a more delicate test; namely, the ability to see the separation between two thin cylinders separated a short distance. Two long cones were made of lignum vitæ (absorption practically identical with that of water). These were 85 mm. long and tapered from 3.2 mm. diameter at the butt to 0.5 mm. at the 82 mm. mark. They were tied to a piece of film base so that the separation was everywhere about one-half their diameter. By raising them varying distances above the film and using a large square focal spot (4 mm.), their shadows could be given varying degrees of (geometric) unsharpness. Figure 1 shows the result using new Patterson par-speed

screens with ordinary good contact; hardnesses 50 kv. peak and 80 kv. peak, both through 2 mm. Al; unsharpnesses from 0 to 3 mm. The shadows were distinguishable on the original film when

$$U_g < 1.3d \qquad (1)$$

Difference between 50 kv. and 80 kv. was imperceptible.

On calculating the profiles of these shadows, it was striking how little injury was done by small degrees of unsharpness and how rapidly the profile became degraded as soon as unsharpness reached the diameter of the cylinder (Fig. 2).

By taking one of these degraded profiles and calculating the effect upon it of a further "dose" of unsharpness, one can

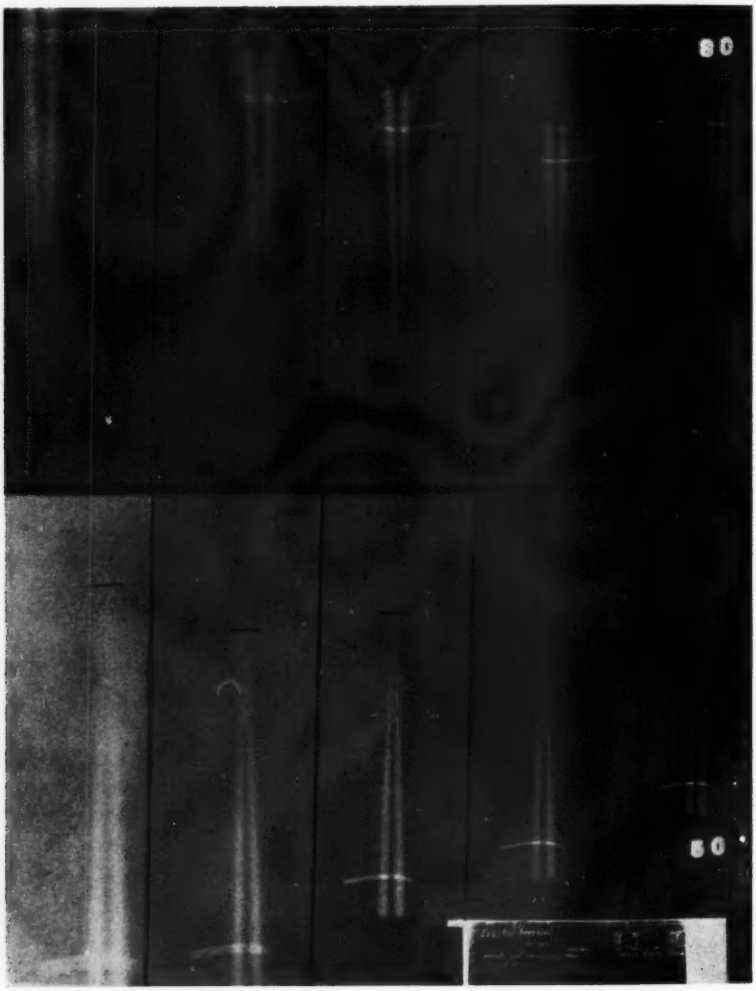

Fig. 1. Visibility of a thin narrow cone in double-screen roentgenograms with varying degrees of unsharpness. 50 kv. and 80 kv. both with 2 mm. Al. Pair of hardwood sticks, 3 mm. diameter near one end, tapering to 0.5 mm. near the other. Unsharpnesses of 0, 0.50, 1.0, 2.0, and 3.0 mm. Shadows run together where unsharpness is 1.3 times diameter of shadow of stick. Increase of object distance in order to increase the unsharpness results in magnification. Truncated end of cone marked in pencil.

get the resultant geometric plus movement unsharpness on the shadow of a thin cylinder. [U_g = 1 mm., U_m = 2 mm.]

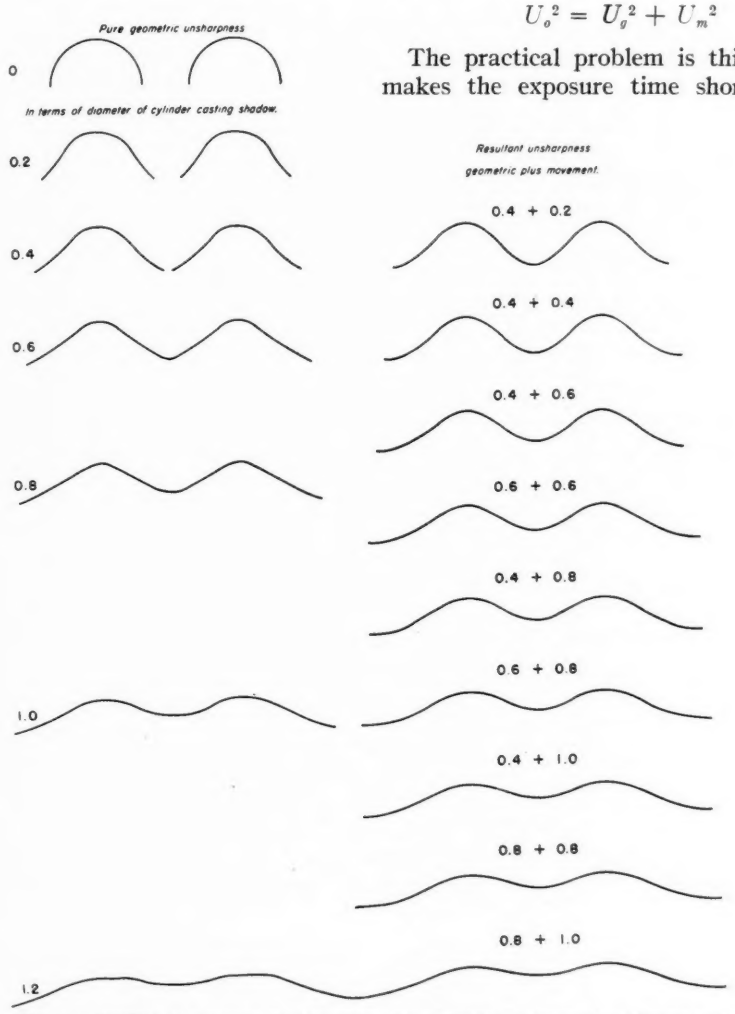

Fig. 2. Profiles of roentgen shadows of a thin cylinder under varying degrees and kind of unsharpness.

gives, of course, the same effect as

$$[U_g = 2 \text{ mm.}, \; U_m = 1 \text{ mm.}].$$

Profiles of the resultants, called U_o, are shown arranged alongside the profiles of the U_g's which they most nearly match, and which may be used as numerical measures of the U_o's. Figure 3 shows a plot of U_o against U_g and U_m. It appears immediately that circles run satisfactorily close to the contours of this plot, and one can write:

$$U_o^2 = U_g^2 + U_m^2 \qquad (2)$$

The practical problem is this: If one makes the exposure time short to stop movement, then the focal spot must be made large to carry the heavy current, and U_g will be large. If one makes the focal spot small, then the tube cannot be loaded so heavily and exposure time must be long, making U_m large. What is the best compromise?

Warren has considered the maximum permissible loading for a line focus (250

watts per actual mm.^{2} of focal spot) and for a rotating target (about six times that), and has calculated and plotted the relation of exposure time to resultant unsharpness, supposing tube distance fixed (say at 1.5 meters) and choosing a diameter of focal spot just big enough to carry the load. Of course this is not what we do. We take our tube with a given focal spot and change the distance, putting it just as far away as we can and still get a full exposure in the given time with the permitted load. This changes the magnification of unsharpnesses as well as of the whole object. Also, Warren ignored the permission to use slightly heavier loads at very short exposure times. By chance these two discrepancies balance within 5 per cent for 4 mm. line focus and 1 mm. rotating target from $^1/_{60}$ sec. to $^1/_4$ sec. I have taken a slightly heavier loading than Warren took as permissible on rotating anode.

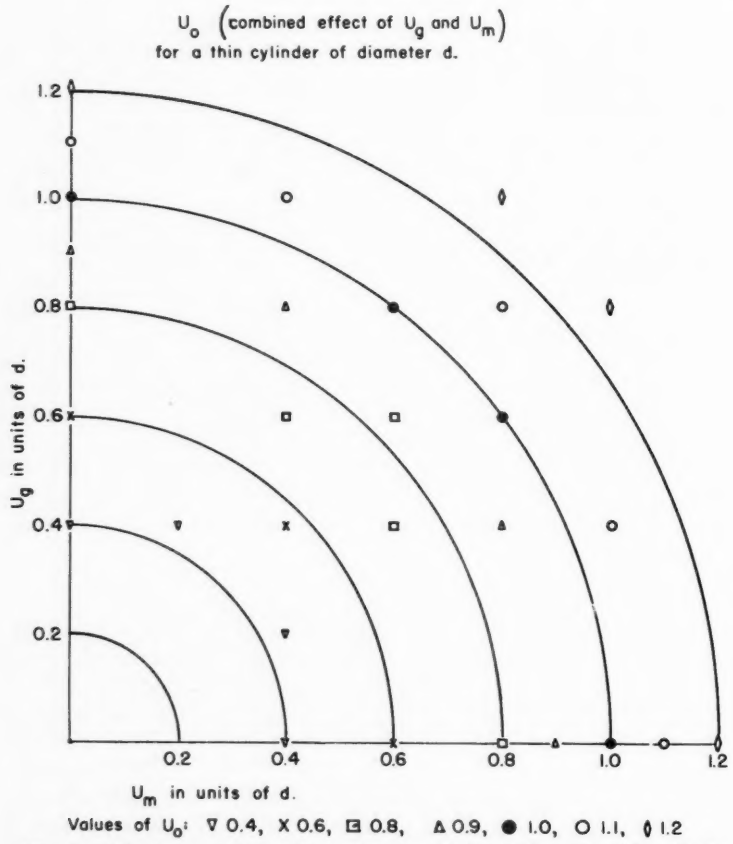

Fig. 3. Effective or "observed" unsharpness of the shadow of a thin cylinder caused by combined action of geometric unsharpness and movement unsharpness. Contours along points of equal observed unsharpness turn out to be circles.

Figure 4 shows how geometric unsharpness increases as one shortens the exposure time and how movement unsharpness increases as one lengthens the exposure time. Adding the two sorts of unsharpness, one observes an optimum exposure time, where total unsharpness is at a minimum. Taking the more accurate evaluation of resultant unsharpness according to Equation 2, one sees that that definition is better than one had thought at first, and that one should choose a slightly different exposure time.

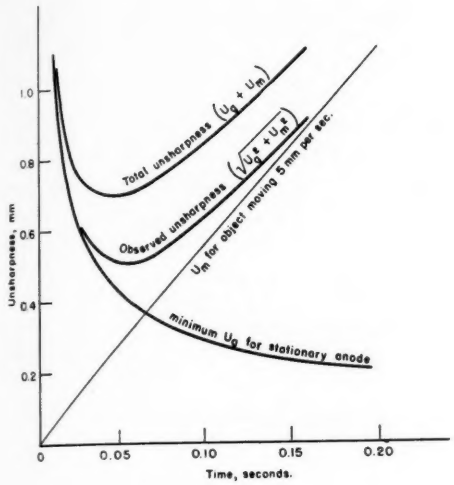

Fig. 4.

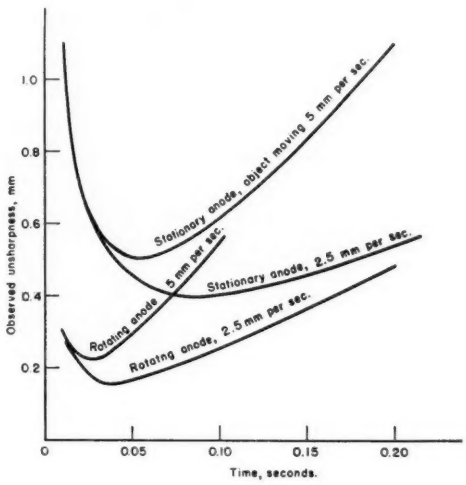

Fig. 5.

Fig. 4. Relation of the two kinds of unsharpness to exposure time, with resultant "observed" unsharpness.
Fig. 5. "Observed" unsharpness related to exposure time for two tube loadings and two speeds of object. Note that the slower the movement, the better the definition and the slower the optimum exposure time.

The results will be different for different speeds of movement and for various permitted tube loadings, of course. Figure 5 shows what betterment one can expect by using a rotating anode, or in case the object is moving only 2.5 mm. per sec. These are the cases considered by Warren. My calculations point to shorter optimum exposures than his do.

The general relationship of best available definition to permitted tube loading is plotted in Figure 6.

Note that the 2 mm. spot on the rotating target is not so good as the 1 mm. spot. Just on the basis of sharp lung detail one would always choose the 1 mm. spot. Of course, the farther the object from the film and the closer the tube (to get quick exposure), the more conditions favor the larger spot. But only if it is desired to get detail in a moving structure 30 cm. from the film and at the same time necessary to set the 1 mm. spot as close as 75 cm. distance would advantage swing in favor of using the 2 mm. spot (at its corresponding longer distance).

CALCULATIONS

It is probably superfluous to repeat the mathematics but a résumé might be in order. Suppose 20 ma.-sec. is necessary for a satisfactory film with tube at 2 meters. We write

$$\text{ma.} = \frac{20}{t} \tag{3}$$

If we can load the tube x ma. per mm.^{2} of focal spot (apparent area), then

$$\text{area} = \frac{\text{ma.}}{x} \tag{4}$$

substituting value of ma. from (3)

$$\text{area} = \frac{20}{tx}. \tag{5}$$

Now geometric unsharpness depends on diameter of focal spot and on distance from tube to film and object to film. Considering lung detail 15 cm. from film,

$$U_g = \frac{15}{200\text{–}15} \times \text{diameter of focal spot},$$

$$U_g^2 = 0.0066 \times \text{area}.$$

Substituting value of area from (5)

$$U_g^2 = \frac{0.132}{tx}.$$

If the object is moving 5 mm. per sec., allowing for magnification,

$$U_m = 5 \times \frac{200}{200-15} t = 5.4t.$$

Substituting this value in Equation (6)

$$U_o^2 = 0.132 \times 7.57x^{1/3}x^{-1} + 29x\,0.0173x^{-2/3}$$
$$= 1.0x^{-2/3} + 0.5x^{-2/3}$$
$$U_o = 1.22x^{-1/3}.$$

(Chantraine has already remarked that sharpness improves only with the third root of the tube loading.)

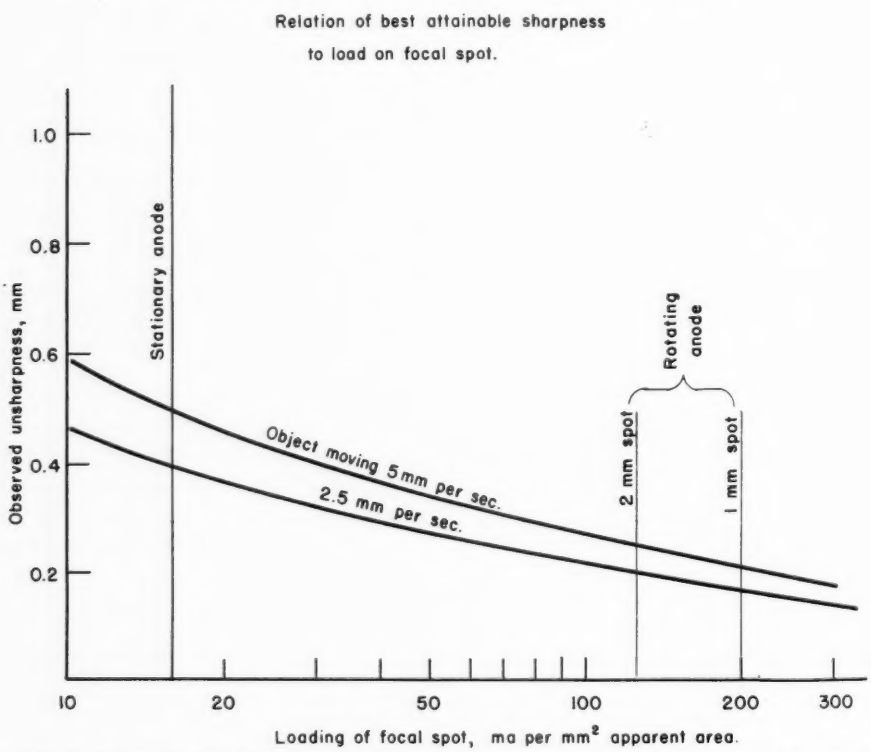

Fig. 6. Economics of tube loading. Gradual improvement in best available definition of a moving object as one increases the permitted loading on the focal spot.

Then from Equation (2)

$$U_o = \frac{0.132}{tx} + 29t^2 \qquad (6)$$

differentiating

$$\frac{dU_o^2}{dt} = -0.132x^{-1}t^{-2} + 58t$$

U_o^2 is at a minimum when

$$58t - 0.132x^{-1}t^{-2} = 0$$
$$t = 0.132x^{-1/3}.*$$

* That the coefficient is the same as in Equation 6 is a mere accident.

If object moves only 2.5 mm. per sec., then

$$U_o' = 0.98x^{-1/3}.$$

Note also that we have now to amend Bouwers' (1) statement that unsharpness is least when geometric unsharpness is twice movement unsharpness, and say instead that

U_o is least when $U_g^2 = 2U_m^2$

i.e., when $U_g = 1.4U_m$.

Most radiologists have become accustomed to take chest films at 2-meter distance. If one uses the 2 mm. focal spot on rotating anode and loads it to its capacity, namely, 500 ma., then at 2 meters the exposure will be $^1/_{24}$ sec. (*i.e.*, 5 half cycles) and one finds U_g = 0.16 mm., U_m = 0.23 mm., giving a resultant U_o = 0.28 mm. This is not optimal, but is far below what seems to be the critical unsharpness, namely 0.5 mm.

For maximum attainable definition of the pulmonary vessels moving as fast as 5 mm. per sec., choose the 1 mm. focal spot on rotating anode and give $^1/_{40}$ sec. (*i.e.* 3 half cycles) at 1 meter with 200 ma. This gives U_g = 0.18 mm. and U_m = 0.15 mm. resultant U_o = 0.23 mm.

If 5 ma.-sec. at 1 meter proves insufficient to give the quality of film desired then a 30 per cent increase in exposure time will still give very sharp shadows,

U_o = 0.34 mm. for 2-meter distance
U_o = 0.27 mm. for 1-meter distance.

Only a portion of the left lung-field shows rapid movement, so one might wisely choose a longer time and a longer distance when interested in the apices which move but little. If it becomes clinically possible to use "directed exposure" at the moment of diastolic pause, there is about $^1/_{20}$ sec. available when the heart hardly moves at all. This would permit reduction of U_g (and U_o) to about 0.11 mm. This brings us down to the order of unsharpness due to film and intensifying screen. I have not investigated these in detail. But if we say their inherent unsharpness is of the order of 0.1 mm. (Chantraine says 0.4 mm.), and apply Equation 2 here also, then the best definition we can hope for with "directed exposure" during the diastolic pause and a rotating anode tube is a resultant unsharpness of 0.14 mm.

This should be adequate to resolve the shadows of two vessels 0.11 mm. in diameter separated 0.06 mm., if only one could get sufficient contrast.

As a matter of fact, present technic gives contrast sufficient only for 0.5 mm. vessels, when no contrast is lost by scattering. The rotating anode tube has, therefore, thrown the problem of showing detail in the lung out of the field of movement and geometric unsharpness into the field of preserving and enhancing contrast. Wilsey (4) has made a preliminary report, but no such quantitative study has yet been made as will permit specification of the optimum technic for chest films.

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THE RÔLE OF PERIRENAL INJECTIONS OF GAS IN THE RADIOLOGICAL STUDY OF THE ADRENAL GLANDS[1]

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PERIRENAL air injections for better roentgen visualization of the kidneys were used as early as 1921 by Carelli, but only recently Cahill and his associates reported the use of this method for the visualization of the adrenal glands. In our opinion this technic is a very valuable one because it often eliminates the danger connected with surgical exploration of the adrenal regions. In this paper we shall attempt to present our own experience with the method and the diagnostic results obtained.

[1] Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13–17, 1937.

TECHNIC

A number of technics were described in the early 1920's for the perirenal injection of gas. From a review of the literature it seems that the original method of Carelli did not give as satisfactory results as the methods described later by Chevassu and Maingot, by Soubiran, and by Morel-Kahn. A study of a cross-section of the body at the level of the second lumbar (Fig. 1) will easily explain why no single method can be expected to give 100 per cent results. Regardless of the technic followed, the injection must be made at a great depth and into a very small space. We have used

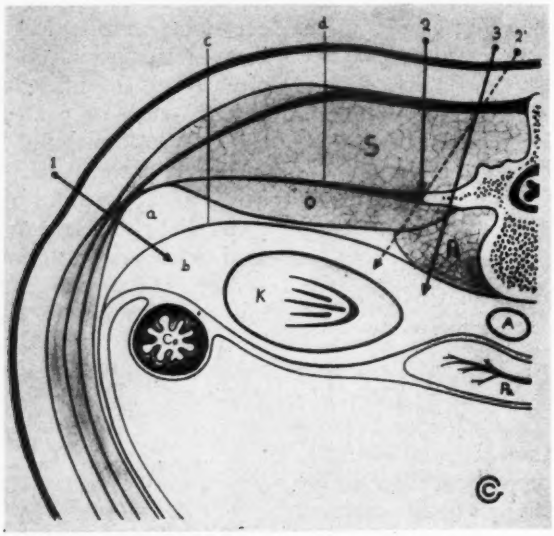

Fig. 1. Cross-section of body at level of the second lumbar vertebra. *1.* Method of Chevassu and Maingot; *2.* Method of Morel-Kahn; *3.* Method of Carelli; *a.* Pararenal space; *b.* Perirenal space; *c.* Zuckerkandl fascia; *d.* Quad. lumbaris fascia; *S.* Sacrospinalis muscle; *Ps.* Psoas muscle; *K.* Kidney; *Q.* Quad. lumbaris muscle; *Pa.* Pancreas; *Co.* Colon, and *A.* Aorta.

the method of Morel-Kahn with slight modifications.

The patient should be prepared in the same manner used for an ordinary roentgenogram of the kidneys. We prescribe one ounce of castor oil to be taken the night preceding the examination, and in the morning as many enemas as necessary to clean the colon of gas and fecal material. After cleansing and sterilizing the skin in the lumbar region, with the patient lying prone, two sterile lead markers are placed on the skin on each side and about three centimeters away from the tip of the spinous process of the second lumbar vertebra. A roentgenogram is then taken, which informs us of the position of the transverse processes of the second lumbar in relation to the markers and also of the amount and location of eventual intestinal gas. If an excessive amount of gas is present, every effort should be made to have the patient expel it (pitressin, additional enemas). If the abdomen is free from gaseous collection, one may proceed with the perirenal injection. Under local anesthesia a small opening is made in the skin at a point corresponding to the middle of the transverse process of the second lumbar. Through this opening the anesthesia is extended to the underlying tissue and a blunt[2] spinal needle is pushed through the sacrospinalis fascia, which offers considerable resistance, and through the underlying muscle until it comes in contact with the transverse process. Once this contact is established the needle must follow the bone to its distal extremity. When the needle slips over the end of the transverse process another resistance is felt while piercing the superficial fascia of the quadriceps lumborum. From this point on, no more appreciable resistances are detectable and the needle should be inserted from 1.5 to 2 cm. farther to reach the perirenal space. As one can see from Figure 1, the fat which surrounds the kidney is divided in two spaces by the fascia of Zuckerkandl. In order to avoid the injection of the space posterior to this fascia, we usually insert the needle deep enough to drive its point into the cortex of the kidney; this means from 2 to 3 cm. from the fascia of the quadriceps lumborum. At this point one should withdraw the stylet and aspirate to make sure that the point of the needle is not in a vein and then connect the needle with an ordinary pneumothorax apparatus. A small amount of air is now injected. If the manometer registers respiratory oscillations, one may proceed without further ado to the injection of from 150 to 250 c.c. of gas. If no oscillations appear, one should withdraw the needle for a short distance, aspirate again, and inject a small amount of air and watch for oscillations of the manometer with respiration or cough. Although some authors do not use this manometric checking of the position of the needle, we feel that it is of great comfort and assistance to the operator. The gas should be injected at a pressure not exceeding 3 cm. of mercury. During the injection, no greater discomfort should be experienced by the patient than a sensation of slightly painful fullness. This sensation lasts until the reabsorption of the gas is complete. The time necessary for this reabsorption varies considerably, according to the gas employed. Carbon dioxide is reabsorbed in a few hours, air in three or four days, and oxygen in from 10 to 20 hours. We use ordinary filtered air.

Since the anatomy of the posterior abdominal wall is quite complicated, errors may arise from injecting gas in any of the many fascial compartments. Injections in the psoas muscle are frequent and give the characteristic appearance of "air in muscle" (Fig. 3). Injections in the fat behind Zuckerkandl fascia may give a fair picture of the adrenals, but more often extend upward under the diaphragm and occasionally into the mediastinum. LaCayo reports that Carelli produced a pneumoperitoneum in one of his patients.

In spite of the many possibilities of error, no fatal accidents have been reported from the extensive use of this method during the

[2] The needle must be blunt to feel the resistance of the various layers.

Fig. 2. Normal adrenal glands visualized by perirenal injection of gas.

Fig. 3. Appearance of gas in psoas muscle.

years 1920 to 1924. It is obvious, however, that the procedure should be used only when there is a sufficiently strong suspicion of adrenal pathology and when objective evidence cannot be obtained by ordinary clinical means.

After a satisfactory injection has been accomplished, the adrenal glands should be studied with roentgenograms taken in the anteroposterior, postero-anterior, and oblique positions, with Bucky grid, in apnea, with exposures not exceeding two seconds. Normal adrenal glands (Fig. 2) will resemble small phrygian caps over the upper poles of the kidney; the average normal size being 3 by 4 cm. Hypertrophy of the adrenals and tumors will be outlined with varying clarity against the dark background of the surrounding gas.

CASE REPORTS

Case 1. A white, unmarried male, 22 years of age, was admitted to the Clinic on Nov. 2, 1936, complaining of "attacks" since August, 1936. He had had these "attacks" for a period of two months, and he also had had these "attacks" for a period of two months two years previously. At that time they were apparently relieved by the extraction of infected wisdom teeth. The "attacks" consisted of a weak feeling over the heart, heavy forceful beating of the heart, nausea, and a "splitting" headache. They occurred at night and usually awakened him from sleep. They seemed to be dependent on nervous strain during the previous day. Each "attack" lasted from five to ten minutes.

Routine examination and x-rays were negative. X-rays following air injection (Fig. 4) showed a round tumor 12 cm. in diameter in the region of the right adrenal. Injections of from 4 to 6 minims of adrenalin intravenously provoked an identical attack in one minute. The blood pressure rose to 220/120, and in from five to eight minutes the blood pressure was normal, and the attack was over. The experiment was done both pre- and post-operatively. On Jan. 8, 1937, a large benign paraganglioma was removed from the site of the right adrenal. There have been no attacks since the removal of the tumor.

Case 2. A white, married female, 50

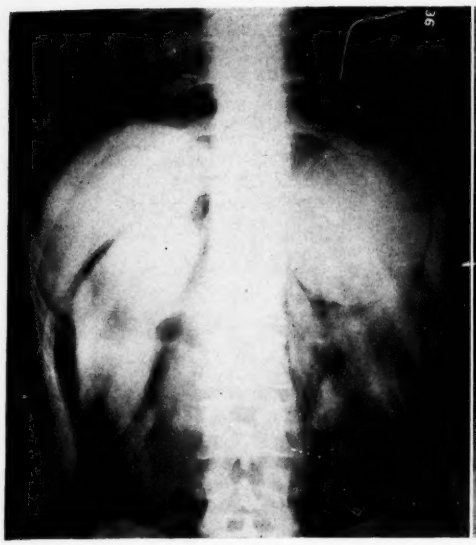

Fig. 4. Case 1. Large paraganglioma of the right adrenal gland.

Fig. 5. Case 2. Hypertrophy of the left adrenal gland.

years of age, was admitted to the Clinic on May 20, 1937. The patient had had a normal pregnancy at the age of 23. She noticed hirsutism and obesity at the age of 25. The menses were regular but scanty. The menopause had occurred two years before admission. Since then, she had had "peculiar spells" at night, occurring at any time from 10 P.M. to 2 A.M. They consisted of upper abdominal pains followed by a crowded feeling in the substernal region, weakness, and cyanosis. She had no idea whether her pulse was fast or slow during the spells. They lasted from a few minutes to a half-hour and were relieved by nitroglycerine. She was never seen by a doctor during an attack.

Examination showed the height to be 5 feet 4 inches, the weight 209 pounds. She had a "buffalo type" of obesity. There was a marked hirsutism of the face, and she had coarse hair on the chest, abdomen, legs, and arms. The blood pressure was 135/85. X-rays of the chest, stomach, gall bladder, and head were all negative. X-rays of the adrenals after air injection (Fig. 5) showed a marked enlargement of the left adrenal shadow. Glucose tolerance showed a positive diabetic curve. The metabolism test was minus 7 per cent. The electrocardiograph showed a rate of 70, sinus rhythm, left ventricular preponderance and diphasic T wave in lead III.

In Case 1 the clinical symptoms pointed to an adrenal disturbance of the medullary type, with sudden discharges of large amounts of adrenalin.

In Case 2 the clinical picture was complicated by cardiac manifestations and diabetes, but the peculiar type of obesity and the marked hypertrychosis made us consider a basophilic adenoma of the pituitary or an adrenal disturbance of cortical origin. In both cases the objective evidence of pathology of the adrenal glands was easily obtained by means of perirenal air injections.

CONCLUSIONS

We believe that the perirenal injection of gas constitutes a valuable method for the objective demonstration of adrenal pathology.

SUMMARY

The authors describe in detail the technic of perirenal injection of gas, discuss the

usefulness of this procedure in the diagnosis of adrenal diseases, and report two illustrative cases.

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RADIOLOGICAL SOCIETIES IN THE UNITED STATES

Editor's Note.—Will secretaries of societies please cooperate with the Editor by supplying him with information for this section.

CALIFORNIA

California Medical Association, Section on Radiology.—Chairman, John D. Lawson, M.D., 1306 California State Bldg., Sacramento; *Secretary,* Karl M. Bonoff, M.D., 1930 Wilshire Blvd., Los Angeles. Meets annually with California Medical Association.

Los Angeles County Medical Association, Radiological Section.—President, John F. Chapman, M.D., 65 N. Madison Ave., Pasadena; *Vice-president,* E. N. Liljedahl, M.D., 1241 Shatto St.; *Secretary,* Merl L. Pindell, M.D., 678 South Ferris Ave.; *Treasurer,* Henry Snure, M.D., 1414 Hope Street. Meets every second Wednesday of month at County Society Building.

Pacific Roentgen Club.—Chairman, Raymond G. Taylor, M.D., 1212 Shatto St., Los Angeles; *Secretary,* L. Henry Garland, M.D., 450 Sutter St., San Francisco.

San Francisco Radiological Society.—Secretary, L. H. Garland, M.D., 450 Sutter Street. Meets monthly on first Monday at 7:45 P.M., alternately at Toland Hall and Lane Hall.

COLORADO

Denver Radiological Club.—President, John S. Bouslog, M.D., 246 Metropolitan Bldg.; *Vice-president,* Sanford Withers, M.D., 304 Republic Bldg.; *Secretary,* Ernst A. Schmidt, M.D., Colorado General Hospital; *Treasurer,* H. P. Brandenburg, M.D., 155 Metropolitan Bldg. Meets third Tuesday of each month at homes of members.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology.—Chairman, Kenneth K. Kinney, M.D., 29 North Street, Willimantic; *Vice-chairman,* Francis M. Dunn, M.D., 100 State Street, New London; *Secretary-Treasurer,* Max Climan, M.D., 242 Trumbull St., Hartford. Meetings twice annually in May and September.

DELAWARE

Affiliated with Philadelphia Roentgen Ray Society.

FLORIDA

Florida State Radiological Society.—President, Gerald Raap, M.D., 168 S. E. First St., Miami; *Vice-president,* H. O. Brown, M.D., 404 First Nat'l Bank Bldg., Tampa; *Secretary-Treasurer,* H. B. McEuen, M.D., 126 W. Adams St., Jacksonville.

GEORGIA

Georgia Radiological Society.—President, James J. Clark, M.D., Doctors Bldg., Atlanta; *Vice-president,* William F. Lake, M. D., Medical Arts Bldg., Atlanta; *Secretary-Treasurer,* Robert C. Pendergrass, M.D., Prather Clinic, Americus. Meetings twice annually, in November and at the annual meeting of the Medical Association of Georgia in the spring.

ILLINOIS

Chicago Roentgen Society.—President, David S. Beilin, M.D., 411 Garfield Ave.; *Vice-president,* Chester J. Challenger, M.D., 3117 Logan Blvd.; *Secretary-Treasurer,* Roe J. Maier, M.D., 7752 Halsted St. Meets second Thursday of each month, September to May, except December.

Illinois Radiological Society.—President, Cesare Gianturco, M.D., 602 W. University Ave., Urbana; *Vice-president,* Fred H. Decker, M.D., 802-Peoria Life Bldg., Peoria; *Secretary-Treasurer,* Edmund P. Halley, M.D., 968 Citizens Bldg., Decatur. Meetings quarterly byannouncement.

Illinois State Medical Society, Section of Radiology.—President, Roswell T. Pettit, M.D., 728 Columbus St., Ottawa; *Secretary,* Ralph G. Willy, M.D., 1138 N. Leavitt St., Chicago.

INDIANA

Indiana Roentgen Society.—President, J. N. Collins, M.D., 23 E. Ohio St., Indianapolis; *President-elect,* Stanley Clark, M.D., 108 N. Main St., South Bend; *Vice-president,* Juan Rodriguez, M.D., 2903 Fairfield Ave., Fort Wayne; *Secretary-Treasurer,* Clifford C. Taylor, M.D., 23 E. Ohio St., Indianapolis. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

MAINE

See New England Roentgen Ray Society.

MARYLAND

Baltimore City Medical Society, Radiological Section.—Chairman, Marcus Ostro, M.D., 1810 Eutaw Place; *Secretary,* H. E. Wright, M.D., 101 W. Read St., Baltimore. Meetings second Tuesday of each month.

MASSACHUSETTS

See New England Roentgen Ray Society.

MICHIGAN

Detroit X-ray and Radium Society.—President, E. W. Hall, M.D., 10 Peterboro Street; *Vice-president,*

Sam W. Donaldson, M.D., 326 North Ingalls St., Ann Arbor; *Secretary-Treasurer*, E. R. Witwer, M.D., Harper Hospital. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society Bldg.

Michigan Association of Roentgenologists.—President, E. R. Witwer, M.D., Harper Hospital, Detroit; *Vice-president*, D. W. Patterson, M.D., 622 Huron Street, Port Huron; *Secretary-Treasurer*, C. K. Hasley, M.D., 1429 David Whitney Bldg., Detroit.

MINNESOTA

Minnesota Radiological Society.—President, Walter H. Ude, M.D., 78 S. 9th St., Minneapolis; *Vice-president*, Leo G. Rigler, M.D., University Hospitals, Minneapolis; *Secretary-Treasurer*, Harry Weber, M.D., 102 Second Ave., S. W., Rochester. Meetings quarterly.

MISSOURI

The Kansas City Radiological Society.—President, L. G. Allen, M.D., 907 N. 7th St., Kansas City, Mo.; *Secretary*, Ira H. Lockwood, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

The St. Louis Society of Radiologists.—President, Joseph C. Peden, M.D., 634 N. Grand Blvd.; *Secretary*, W. K. Mueller, M.D., 607 N. Grand Blvd. Meetings fourth Wednesday of each month.

NEBRASKA

Nebraska Radiological Society.—President, E. W. Rowe, M.D., 128 N. 13th St., Lincoln; *Secretary*, D. Arnold Dowell, M.D., 117 S. 17th St., Omaha. Meetings first Wednesday of each month at 6 P.M. in Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

(Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island.) *President*, Frank E. Wheatley, M.D., 520 Beacon St., Boston; *Secretary*, E. C. Vogt, M.D., 300 Longwood Ave., Boston. Meetings third Friday of each month from October to May, inclusive, usually at Boston Medical Library.

NEW HAMPSHIRE

See New England Roentgen Ray Society.

NEW JERSEY

Radiological Society of New Jersey.—President, J. D. Tidaback, M.D., 382 Springfield, Summit; *Vice-president*, Milton Friedman, M.D., Newark Beth Israel Hospital, Newark; *Secretary*, P. S. Avery, M.D., 546 Central Ave., Bound Brook. Meetings at Atlantic City at time of State Medical Society, and Midwinter in Newark as called by president.

NEW YORK

Brooklyn Roentgen Society.—President, Albert Voltz, M.D., 115–120 Myrtle Avenue, Richmond Hill; *Vice-president*, A. L. L. Bell, M.D., Long Island College Hospital, Henry, Pacific, and Amity Sts., Brooklyn; *Secretary-Treasurer*, E. Mendelson, M.D., 132 Parkside Ave., Brooklyn. Meetings first Tuesday in each month at place designated by president.

Buffalo Radiological Society.—President, John Barnes, M.D., 875 Lafayette Ave.; *Vice-president*, W. L. Mattick, M.D., 290 Highland Drive; *Secretary-Treasurer*, J. S. Gian-Franceschi, M.D., 610 Niagara Street. Meetings second Monday evening each month.

Central New York Roentgen-ray Society.—President, W. E. Achilles, M.D., 60 Seneca St., Geneva; *Vice-president*, M. T. Powers, M.D., 250 Genesee St., Utica; *Secretary-Treasurer*, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings held in January, May, and October as called by Executive Committee.

Long Island Radiological Society.—President, David E. Ehrlich, M.D., 27 W. 86th St., New York City; *Vice-president*, H. Koiransky, M.D., 43–37 47th St., Long Island City; *Secretary*, S. Schenck, M.D., 115 Eastern Parkway, Brooklyn; *Treasurer*, Moses Goodman, M.D., 45–01 Skillman Ave., Long Island City. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—President, E. F. Merrill, M.D., 30 W. 59th St., New York City; *Vice-president*, I. W. Lewis, M.D.; *Secretary*, H. K. Taylor, M.D., 667 Madison Ave., New York City; *Treasurer*, R. D. Duckworth, M.D., 170 Maple Ave., White Plains. Meetings third Monday evening each month at Academy of Medicine.

Rochester Roentgen-ray Society.—Chairman, Joseph H. Green, M.D., 277 Alexander St.; *Secretary*, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

Society of Radiological Economics of New York.—President, Albert L. Voltz, M.D., 115–120 Myrtle Ave., Richmond Hill; *Vice-president*, M. M. Pomeranz, M.D., 911 Park Ave., New York City; *Secretary*, W. F. Francis, M.D.; *Treasurer*, Theodore West, M.D., United Hospital, Port Chester. Meetings first Monday evening each month at McAlpin Hotel.

NORTH CAROLINA

Radiological Society of North Carolina.—President, Robert P. Noble, M.D., 127 W. Hargett St., Raleigh; *Vice-president*, A. L. Daughtridge, M.D., 144 Coast Line St., Rocky Mount; *Secretary-Treasurer*, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meetings with State meeting in May, and meeting in October.

OHIO

Cleveland Radiological Society.—President, North W. Shetter, M.D., Lakewood City Hospital, Lakewood; *Vice-president*, John Heberding, M.D., St. Eliza-

beth's Hospital, Youngstown; *Secretary-Treasurer*, Harry Hauser, M.D., Cleveland City Hospital, Cleveland. Meetings at 6:30 P.M. at Cleveland Chamber of Commerce Club on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*President*, George Benzing, M.D., St. Elizabeth Hospital, Covington, Ky.; *Secretary-Treasurer*, Justin E. McCarthy, M.D., 707 Race St., Cincinnati, Ohio. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—President, Sydney J. Hawley, M.D., Geisinger Memorial Hospital, Danville; *First Vice-president*, William J. McGregor, M.D., 744 Franklin Ave., Wilkinsburg; *Second Vice-president*, Oscar M. Weaver, M.D., 12 S. Main St., Lewistown; *Secretary-Treasurer*, Lloyd E. Wurster, M.D., 416 Pine St., Williamsport; *President-elect*, Charles S. Caldwell, M.D., 520 S. Aiken Ave., Pittsburgh. Annual meeting, May, 1938. Exact date and place to be decided.

Philadelphia Roentgen Ray Society.—President, Thomas P. Laughery, M.D., Germantown Hospital; *Vice-president*, Elwood E. Downs, M.D., Jeans Hospital, Fox Chase; *Secretary*, Barton H. Young, M.D., Temple University Hospital; *Treasurer*, R. Manges Smith, M.D., Jefferson Hospital. Meetings first Thursday of each month from October to May, Thompson Hall, College of Physicians, 19 S. 22nd St., 8:15 P.M.

The Pittsburgh Roentgen Society.—President, F. L. Schumacher, M.D., Jenkins Arcade; *Secretary*, H. N. Mawhinney, M.D., Mercy Hospital. Two Fall and two Spring meetings at time and place designated by president.

RHODE ISLAND

See New England Roentgen Ray Society.

SOUTH CAROLINA

South Carolina X-ray Society.—President, Robert B. Taft, M.D., 105 Rutledge Ave., Charleston; *Secretary-Treasurer*, Hillyer Rudisill, M.D., Roper Hospital, Charleston. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

SOUTH DAKOTA

Meets with Minnesota Radiological Society.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee State Radiological Society.—President, H. S. Shoulders, M.D., 246 Doctors Bldg., Nashville; *Vice-president*, S. S. Marchbanks, M.D., 508 Medical Arts Bldg., Chattanooga; *Secretary-Treasurer*, Franklin B. Bogart, M.D., 311 Medical Arts Bldg., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Texas Radiological Society.—President, R. G. Giles, M.D., Medical Arts Bldg., San Antonio; *President-elect*, Jerome H. Smith, M.D., Shannon West Texas Memorial Hospital, San Angelo; *First Vice-president*, C. F. Crain, M.D., 416 Chaparral St., Corpus Christi; *Second Vice-president*, M. H. Glover, M.D., 904 8th St., Wichita Falls; *Secretary-Treasurer*, G. D. Carlson, M.D., 3121 Bryan St., Dallas. Meets annually. San Antonio is next place of meeting.

VERMONT

See New England Roentgen Ray Society.

VIRGINIA

Radiological Society of Virginia.—President, Fred M. Hodges, M.D., 100 W. Franklin St., Richmond; *Vice-president*, L. F. Magruder, M.D., Raleigh and College Aves., Norfolk; *Secretary*, V. W. Archer, M.D., University of Virginia Hospital, Charlottesville.

WASHINGTON

Washington State Radiological Society.—President, H. E. Nichols, M.D., Stimson Bldg., Seattle; *Secretary*, T. T. Dawson, M.D., Fourth and Pike Bldg., Seattle. Meetings fourth Monday of each month at College Club.

WISCONSIN

Milwaukee Roentgen Ray Society.—Secretary, S. A. Morton, M.D., Columbia Hospital, Milwaukee. Meets monthly on first Friday.

Radiological Section of the Wisconsin State Medical Society.—Secretary, Russel F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

EDITORIAL

LEON J. MENVILLE, M.D., *Editor* HOWARD P. DOUB, M.D., *Associate Editor*

TUMOR CLINICS

The alarming mortality figures for cancer with which statisticians confront us at frequent intervals are indeed disquieting. The enthusiastic physician in intimate contact with all that modern medicine offers the cancer victim finds the situation difficult of comprehension. He knows that the skilled workers with whom he is associated make new inroads on the progress of this disease each year and yet their results seem to have little influence on the statistics of the country as a whole.

A Utopia in which every patient might receive early diagnosis and the most efficient known treatment would unquestionably change these figures for the better, but let us waste no time on Utopian ideals. More can be gained perhaps from a consideration of the opinions of those most concerned Everyone who works with cancer is prone to place the blame for the low total salvage on someone else.

For instance, the surgeon who sees a patient with a cancer of the lip where insufficient x-ray dosage has been used is convinced that radiologists are standing in the way of progress in cancer therapy. He is likely to be more upset, and justifiably so, when he sees a patient with a cancer of the breast which has become inoperable while receiving inefficient x-ray therapy. In his righteous wrath he does not realize that the individual rather than the method should receive his condemnation.

And, of course, the thing works just as well in reverse. Almost every radiologist must contend with the bold surgeon who ruthlessly attacks every case of inoperable carcinoma with which he comes in contact, thereby becoming a courageous hero who has tried and failed in the eyes of the family. There are also in every community many surgeons who honestly believe that surgery offers the only hope of a cure to patients with cancer of the lip, mouth, throat, and uterus, and advise strenuously against the newer methods with which they are unfamiliar. Obviously little hope exists for combined methods under such circumstances.

Both the surgeon and the radiologist point frequently to the general practitioner as the offender and in many instances the fault is his, although he usually errs only because of lack of training. The woman from the small town, with uterine hemorrhage treated without an examination for the "change of life," and the man with a tumor of the tongue treated by watchful waiting are tragic examples of this type of inefficiency, all too frequently encountered.

Medical men as a group often feel that the patient himself is the stumbling block because he does not come earlier for treatment. Assuming that he is intelligent enough to suspicion that he has cancer, what does the average layman do? In most instances he first consults a friend, and the chances are that the advice received will be based on one of the quack radio broadcasts or on quack newspaper advertising. Since this type of propaganda, which invariably attacks all efficient methods of treatment, is made available to almost every community and in many instances constitutes the only information at hand, the layman who does not consult a physician really should not be criticized too strenuously.

Obviously many of these difficulties could be ironed out if reliable information about cancer were more widely disseminated in both medical and lay circles. Laymen can hardly be expected to accept methods of treatment which are viewed with suspicion by physicians in whom they have confidence, and the first problem to be met is within the profession itself.

A tumor clinic organized along the lines suggested by the College of Surgeons and made up of competent progressive men who are open-minded and eager to learn from one another can do much to eliminate misconceptions and

establish a high level of cancer therapy in a community. Seven years ago such a group was organized in the Baylor University Medical School. It is made up of fifteen well-trained men who work together in the outpatient department where only charity patients are used for study. Since practically no endowment is available, teaching, rather than the treatment of large numbers of patients, is considered to be the function of the clinic. Demonstrations are held each week before the senior students and all the physicians in the city are invited to attend and take an active part in the discussions. At intervals, joint presentations are made by members of the clinic staff before the hospital staff and before county medical societies. In the beginning many bitter arguments arose relative to methods of treatment, but the trial-and-error plan gradually eliminated these differences of opinion by vindicating those procedures which produced good results. At present the men who work in the clinic are practically agreed on plans of therapy and present a solid front when they participate in group programs. The formal exercises before students encourage study and accuracy, and the young men leaving the institution carry a knowledge of early diagnosis and proper treatment to other communities where its influence must eventually manifest itself. The slogan "consult your physician early" cannot mean very much to the layman until some such plan has become effective, particularly in the southern portions of the United States where accredited tumor clinics are widely scattered.

Pathology, surgery, and radiology form the triangle about which such clinics must be constructed, and the radiologist with his technical and clinical knowledge and experience in departmental organization is peculiarly fitted for leadership in work of this sort. Radiologists can do their bit for humanity in no better way than to energetically promote the tumor clinic plan so ably fostered by the American College of Surgeons.

CHARLES L. MARTIN, M.D.

COMMUNICATIONS

SECOND ANNUAL CLINICAL CONFERENCE OF MIDWESTERN RADIOLOGISTS

Kansas City, Mo., Feb. 11–12, 1938

The Midwesterns Radiologists held an exceptionally good meeting, with an attendance of more than two hundred and fifty who gathered from fourteen States, Canada, and one foreign country. The banquet was preceded by a cocktail party, the evening being one of good fellowship and informality. The principal speaker at the dinner was Mr. Tom Collins of the *Kansas City Journal-Post*, whose subject was "Seeing is not Believing."

The program follows:

Clinical Significance of the Tuberculin Test. Herbert L. Mantz, M.D., Director Tuberculosis Clinics, Health Dept., Kansas City, Mo.

Roentgenological Manifestation of Childhood Tuberculosis. E. R. Deweese, M.D., F.A.C.R., Radiologist, St. Mary's Hospital.

Discussion—Hubert Parker, M.D., Attending Physician, St. Mary's Hospital.

Clinical, Roentgenological, and Pathological Findings in Secondary Lung Tumors. Charles E. Bell, M.D., Asst. Radiologist, Research Hospital.

Discussion—Frederick C. Narr, M.D.

Correlation of the Clinical and Roentgenokymographic Findings. Graham Asher, M.D., Associate in Medicine, Univ. of Kansas School of Medicine.

Clinical Differentiation of Coronary Disease and Upper Abdominal Pathology. Joseph E. Welker, M.D., Asst. Prof. Medicine, Univ. of Kansas School of Medicine.

Clinical Analysis of Sudden Death from Cardiac Disease. C. G. Leitch, M.D., Pathologist, St. Mary's Hospital.

Discussion—Galen Tice, M.D., Radiologist, University of Kansas Hospitals.

Evolution of Radiation Therapy for Carcinoma of the Cervix. E. H. Skinner, M.D., F.A.C.R., Consulting Radiologist, Kansas City General Hospitals.

Discussion—David S. Dann, M.D.

Symposium on the Breast

Anatomy of the Breast. H. C. Tracy, M.D., Prof. Anatomy, University of Kansas School of Medicine.

The Roentgen Examination of the Breast. Ira H. Lockwood, M.D., F.A.C.R., Radiologist, Research Hospital.

Pathology of the Breast. Frederick C. Narr, M.D., Pathologist, Research Hospital.

Benign Lesions of the Breast. James E. Stowers, M.D., F.A.C.S., Attending Surgeon, Research Hospital.

Clinical and Roentgenological Data in Brucellosis (Undulant Fever). Fred E. Angle, M.D., F.A.C.P., Attending Physician, Bethany Hospital.

Discussion—Lewis G. Allen, M.D.

During the meeting of the Midwestern Radiologists in Kansas City, February 11, an interview between (*left to right*) Edward H. Skinner, M.D., President of the American Radium Society; B. R. Kirklin, M.D., President of the American Roentgen Ray Society, and W. Edward Chamberlain, M.D., Chairman of the American Board of Radiology, was broadcast over KMBC. The object was to give the radio audience a better understanding of the practical application of radiology.

The Visualization and Diagnosis of Breast Lesions by Means of Contrast Roentgenograms. N. Frederick Hicken, M.D., Associate Prof. Surgery, Univ. of Nebraska College of Medicine, Omaha (by invitation).

The Surgical Treatment of Carcinoma of the Breast. Claude J. Hunt, M.D., F.A.C.S., Attending Surgeon, Research Hospital.

The Value of Radiation Treatment of Carcinoma of the Breast. Lewis G. Allen, M.D., F.A.C.R., Prof. Clinical Roentgenology, Univ. of Kansas School of Medicine.

Discussion—E. H. Skinner, M.D.

Correlation of Clinical, Encephalographic, and Ventriculographic Findings. F. R. Teachenor, M.D., F.A.C.S., Associate Clinical Prof. Surgery, Univ. of Kansas School of Medicine.

Discussion—Galen Tice, M.D.

Clinical Analysis of Low Back Pain. Frank D. Dickson, M.D., F.A.C.S., Chief Orthopedist, St. Luke's Hospital.

Discussion—C. Edgar Virden, M.D., F.A.C.R., Radiologist, St. Joseph Hospital.

The Problem of Acute Intestinal Obstruction. Thomas G. Orr, M.D., F.A.C.S., Prof. Surgery, Univ. of Kansas School of Medicine.

The Value of the X-ray Examination in Acute Intestinal Obstruction. David S. Dann, M.D., F.A.C.R., Radiologist, Menorah Hospital.

Discussion—L. W. Paul, M.D., Radiologist, St. Luke's Hospital.

Clinical and Roentgenological Features of Endocrine Lesions. W. M. Ketcham, M.D., Attending Physician, St. Joseph Hospital.

Discussion—C. Edgar Virden, M.D.

Clinical and Roentgenological Findings in Trauma of the Genito-urinary Tract. R. Lee Hoffman, M.D., Chief Urologist, Research Hospital.

Discussion—Ira H. Lockwood, M.D.

Clinical and Radiological Features of Menorrhagia. T. J. Sims, Jr., M.D., Associate in Obst. and Gynec., Univ. of Kansas School of Medicine.

Ovarian Influence in Cancer. Ferdinand C. Helwig, M.D., F.A.C.P., Associate Prof. Pathology, Univ. of Kansas School of Medicine.

Discussion—Lewis G. Allen, M.D.

Neurogenic Factors in Functional Gastro-intestinal Disturbances. P. T. Bohan, M.D., F.A.C.P., Prof. Medicine, Univ. of Kansas School of Medicine.

Discussion—E. R. Deweese, M.D.

It 's True but Who would have Thought of It? (3:15 to 5 P.M.). L. G. Allen, M.D., David S. Dann, M.D., E. R. Deweese, M.D., Ira H. Lockwood, M.D., L. W. Paul, M.D., Galen Tice, M.D., C. Edgar Virden, M.D.

INTERNATIONAL RECOMMENDATIONS FOR X-RAY AND RADIUM PROTECTION

REVISED BY THE INTERNATIONAL X-RAY AND RADIUM PROTECTION COMMISSION AT THE FIFTH INTERNATIONAL CONGRESS OF RADIOLOGY, CHICAGO, SEPTEMBER, 1937

INTERNATIONAL RECOMMENDATIONS

1. The dangers of over-exposure to x-rays and radium can be avoided by the provision of adequate protection and suitable working conditions. It is the duty of those in charge of x-ray and radium departments to ensure such conditions for their personnel. The known effects to be guarded against are:

(*a*) Injuries to the superficial tissues;
(*b*) Changes in the blood and derangements of internal organs, particularly the generative organs.

The evidence at present available appears to suggest that under satisfactory working conditions, a person in normal health can tolerate exposure to x-rays or radium gamma rays to an extent of about 0.2 international roentgen (r) per day, or 1 r per week. On the basis of continuous irradiation during a working day of seven hours, this figure corresponds to a tolerance dosage rate of 10^{-5} r per second. The protective values given in these recommendations are generally in harmony with this figure under average conditions.

I. WORKING HOURS, ETC.

2. The following working hours, etc., are recommended for whole-time x-ray and radium workers:

(*a*) Not more than seven working hours a day in temperate or cold climates. For workers in tropical climates, shorter hours may be desirable.
(*b*) Not more than five working days a week; the off-days to be spent as much as possible out of doors.
(*c*) Not less than four weeks' holiday a year, preferably consecutively.
(*d*) Whole-time workers in hospital x-ray and radium departments should not be called upon for other hospital service.
(*e*) X-ray, and particularly radium workers, should be systematically submitted, both on entry and subsequently at least twice a year, to expert medical, general, and blood examinations, special attention being paid to the hands. These examinations will determine the acceptance, refusal, limitation, or termination of such occupation.
(*f*) The amount of radiation received by operators should be systematically checked to ensure that the tolerance dose is not exceeded. For this purpose, photographic films or small-capacity condensers may be carried on the person.

II. GENERAL X-RAY AND RADIUM RECOMMENDATIONS

3. X-ray departments should not be situated below ground-floor level.

4. All rooms, including dark rooms, should be provided with windows affording good natural lighting and ready facilities for admitting sunshine and fresh air whenever possible.

5. All rooms should be provided with adequate exhaust ventilation. In certain climates it may be necessary to have recourse to air conditioning. For rooms of normal dimensions, say 3,000 cubic feet (90 c. meters) in which corona-free apparatus is installed, the ventilating system should be capable of renewing the air of the room not less than six times per hour, while up to ten times may be required when the apparatus is not corona-free. Large rooms require proportionately fewer changes

of air per hour than small ones. Air inlets and outlets should be arranged to afford crosswise ventilation of the room.

6. All rooms should preferably be decorated in light colors.

7. A working temperature of about 18°–22° C. (65°–72° F.) is desirable in x-ray rooms.

8. X-ray rooms should be large enough to permit a convenient lay-out of the equipment. A minimum floor area of 250 sq. ft. (25 sq. meters) is recommended for x-ray rooms, and 100 sq. ft. (10 sq. meters) for dark rooms. Ceilings should be not less than 11 ft. (3.5 meters) high.

9. High tension generators employing mechanical rectification should preferably be placed in a separate room from the x-ray tube.

III. X-RAY PROTECTIVE RECOMMENDATIONS

10. An x-ray operator should on no account expose himself to a direct beam of x-rays.

11. An operator should place himself as remote as practicable from the x-ray tube. It should be borne in mind that valve tubes are capable of producing x-rays.

12. The x-ray tube should be self-protected, or otherwise surrounded as completely as possible, with protective material of adequate lead equivalent.[1]

13. The following lead equivalents are recommended under average conditions:

X-rays generated by peak voltages	Minimum equivalent thickness of lead
Not Exceeding 75 kv.	1 mm.
100	1.5
125	2
150	2.5
175	3
200	4
250	6
300	9
350	12
400	15
(600)	(35)

(*A*) *Diagnostic Work.*—14. In the case of diagnostic work with other than completely protected tubes, the operator should be afforded additional protection from stray radiation by a screen of a minimum lead equivalent of one millimeter.

15. Screening examinations should be conducted as rapidly as possible with minimum intensities and apertures, particularly when fractures are reduced under x-rays. Palpation with the hand should be reduced to the minimum.

16. The lead glass of fluorescent screens should have the protective values recommended in Paragraph 13.

17. In the case of screening stands, the fluorescent screen should, if necessary, be provided with a protective "surround," so that adequate protection against direct radiation is afforded for all positions of the screen and diaphragm.

18. Screening stands and couches should provide adequate arrangements for protecting the operator against scattered radiation from the patient.

19. Protective gloves, which should be suitably lined with fabric or other material, should have a protective value not less than one-third millimeter lead throughout both back and front (including fingers and wrist). Protective aprons should have a minimum lead value of one-half millimeter.

(*B*) *Treatment.*—20. In the case of x-ray treatment, the operator is best stationed completely outside the x-ray room behind a protective wall, the lead equivalent of which will depend on the circumstances. In the case of a single x-ray tube excited by voltages up to 200 kv., the protective wall should have a minimum lead equivalent of two millimeters. This figure should be increased in the case of higher exciting voltages or of heavy tube currents or if the protective value of the x-ray tube enclosure falls short of the value given in Paragraph 13. In such event the remaining walls, floor, and ceiling may also be required to provide supplementary protection for adjacent occupants to an extent depending on the circumstances. Full protection should be provided in all those directions in which the direct beam can operate.

Inspection windows in screens and walls should have protective lead values equivalent to that of the surrounding screen or wall.

21. In those cases in which an x-ray tube is continuously excited and treatment periods are regulated by means of a shutter, some form of remote control should be provided for the shutter, to ensure that the operator is not exposed to direct radiation while manipulating the shutter or filter.

22. Efficient safeguards should be adopted to avoid the omission of a metal filter in x-ray treatment, for example, by an interlocking device or by continuously measuring the emergent

[1] The lead equivalent of a given thickness of protective material is that thickness of lead which is equally opaque to x-rays excited at some specified peak voltage.

radiation. Protective screens and applicators (cones) used in treatment to define the ports of entry of x-ray beams should be sufficiently thick to reduce the dosage rate outside the direct field of irradiation to less than 10^{-3} roentgen per second.

IV. ELECTRICAL PRECAUTIONS IN X-RAY ROOMS

23. The floor-covering of the x-ray rooms should be insulating material such as wood, rubber, or linoleum.

24. Where permanent overhead conductors are employed, they should be not less than 9 feet (3 meters) from the floor. They should consist of stout metal tubing or other coronaless type of conductor. The associated connecting leads should be of coronaless wire kept taut by suitable rheophores.

25. Wherever possible, earthed guards or earthed sheaths should be provided to shield the more adjacent parts of the high tension system. Unshielded leads to the x-ray tube should be in positions as remote as possible from the operator and the patient. The use of "shock-proof" x-ray equipment, in which the high tension circuit is completely enclosed in earthed conductors, is recommended. In all cases, however, indiscriminate handling of x-ray tubes during operation should be forbidden. Unless there are reasons to the contrary, metal parts of the apparatus and room should be efficiently earthed.

26. Main and supply switches should be very accessible and distinctly indicated. They should not be in the proximity of the high tension system, nor should it be possible for them to close accidentally The use of quick-acting, double-pole circuit breakers is recommended. Over-powered fuses should not be used. If more than one apparatus is operated from a common generator, suitable high tension, multi-way switches should be provided. In the case of some of the constant potential generators, a residual charge is held by the condensers after shutting down, and a suitable discharging device should, therefore, be fitted. Illuminated warning devices which operate when the equipment is "alive" serve a useful purpose. The staff should be trained in the use of first-aid instructions dealing with electrical shock. If foot switches are used they should be connected in series with an ordinary switch, and should be so designed that they cannot be locked to keep the circuit "alive," and are not capable of being closed accidentally.

27. Some suitable form of kilovoltmeter should be provided to afford a measure of the voltage operating the x-ray tube.

28. Low flash-point anesthetics should never be used in conjunction with x-rays.

V. FILM STORAGE PRECAUTIONS

29. The use of non-inflammable x-ray films is strongly recommended. In the case of inflammable films, suitable precautions should be taken as regards their use and storage. Large stocks should be kept in isolated stores, preferably in a separate building or on the roof.

VI. RADIUM PROTECTIVE RECOMMENDATIONS

(*A*) *Radium Salts.*—30. Protection for radium workers is required from the effects of:

(*a*) Beta rays upon the hands;

(*b*) Gamma rays upon the internal organs, vascular and reproductive systems.

31. In order to protect the hands from beta rays, reliance should be placed, in the first place, on distance. The radium should be manipulated with long-handled forceps, and should be carried from place to place in long-handled boxes, lined on all sides with at least one centimeter of lead. All manipulations should be carried out as rapidly as possible.

32. Radium, when not in use, should be stored in a safe as distant as possible from the personnel. It is recommended that the safe should be provided with a number of separate drawers individually protected. The amount of protection should correspond to the values given in the following table. These values, which are based on working conditions where there is proximity to radium, may be reduced for larger working distances.

Maximum Quantity of Radium Element	Thickness of Lead
0.05 gm.	5 cm.
0.2	8.5
0.5	10
1.0	11.5
2.0	13
5.0	15
10.0	17

33. A separate room should be provided for the "make-up" of screened tubes and applicators, and this room should be occupied only during such work.

34. In order to protect the body from the penetrating gamma rays during handling of

radium, a screen of not less than 2.5 centimeters of lead should be used, and proximity to the radium should occur only during actual work, and for as short a time as possible.

35. The measurement room should be a separate room, and it should preferably contain the radium only during its actual measurement.

36. Nurses and attendants should not remain in the same room as patients undergoing radium treatment with quantities exceeding one-half gramme.

37. All unskilled work, or work which can be learned in a short period of time, should preferably be carried out by temporary workers, who should be engaged on such work for periods not exceeding six months. This applies especially to nurses and those engaged in "making up" applicators.

38. Radium containers should be tested periodically for leakage of radon. Prejudicial quantities of radon may otherwise accumulate in radium safes, etc., containing a number of leaky containers.

39. Discretion should be exercised in transmitting radium salts by post. In the case of small quantities (less than 10 mg. of radium element) it is recommended that the container should be lined throughout with lead not less than three millimeters thick, while for quantities between 10 and 50 mg. of radium element, the lead container should be supported in the center of a box with a minimum dimension of 30 cm. Packages containing more than 50 mg. of radium element are preferably sent by rail or hand under suitable conditions of protection.

(*B*) *Radon.*—40. In the manipulation of radon, protection against beta and gamma rays is required, and automatic or remote controls are desirable.

41. The handling of radon should be carried out, as far as possible, during its relatively inactive state.

42. Precautions should be taken against excessive gas pressures in radon plants. The escape of radon should be very carefully guarded against, and the room in which it is prepared should be provided with an exhaust fan controlled from outside the room.

43. Where radon is likely to come in direct contact with the fingers, thin rubber gloves should be worn to avoid contamination of the hands with active deposit. Otherwise, the protective measures recommended for radium salts should be carried out.

44. The pumping room should preferably be contained in a separate building. The room should be provided with a connecting tube from the special room in which the radium is stored in solution. The radium in solution should be heavily screened to protect people working in adjacent rooms. This is preferably done by placing the radium solution in a lead-lined box, the thickness of lead recommended being according to the table in Paragraph 32.

(*C*) *Radium-beam Therapy.*—45. The risks to the operator attendant on the use of large quantities of radium in radium-beam therapy may be largely obviated if some system of remote control is adopted by which the radium is only introduced into the "bomb" after the latter has been adjusted in position on the patient. If such arrangements are not available, the importance of expeditious handling is stressed.

46. Rooms used for radium-beam therapy should provide adequate protection for adjacent wards and rooms in permanent occupation.

The following minimum lead thicknesses are required to secure a tolerance dosage rate of 10^{-5} roentgen per second at various distances from different quantities of radium.

Quantity of Radium Element (0.5 mm. Pt screen)	Thickness of Lead to Give Tolerance Dosage Rate at the Following Distances from Radium Source				Tolerance Distance with No Lead
	50 cm.	1 meter	2 meters	5 meters	
gm.	cm.	cm.	cm.	cm.	meters
1	9.0	6.0	3.0	...	4.5
2	10.5	7.5	4.5	1.0	6.5
5	12.5	9.5	6.5	2.5	10.5
10	14.0	11.0	8.0	4.0	14.5

The distances corresponding to the tolerance dosage rate in the absence of lead are also given.

Members of Committee Making Above Report

DR. G. W. C. KAYE,
(Great Britain) *Hon. Secretary*
Dr. H. BEHNKEN, Germany
PROF. E. PUGNO-VANONI, Italy
Dr. I. SOLOMON, France
MR. LAURISTON S. TAYLOR, U. S. A.

BOOKS RECEIVED

Books received are acknowledged under this heading, and such notice may be regarded as an acknowledgment of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

EINFUHRUNG IN DIE KURZWELLENTHERAPIE (Introduction to Short Wave Therapy). Second Edition. Behandlungstechnik und Indikationen (Technic of Management and Indications). By ERNST FRITSCH and MARTIN SCHUBART. A volume of 200 pages, with 117 illustrations. Published by Urban & Schwarzenberg, Berlin, 1938. Price: RM. 5.50.

RADIUM LOST AND FOUND. By ROBERT B. TAFT, M.D., B.S., M.A., F.A.C.R. A monograph of 76 pages. Published by John J. Furlong and Son, Charleston, S. C., 1938. Price: $2.00.

THE ORIGIN AND PROPERTIES OF THE HUMAN AURA. By OSCAR BAGNALL, B.A. (Cantab.). A volume of 192 pages. Published by E. P. Dutton & Company, Inc., New York City, 1938. Price: $2.00.

THIRD SYMPOSIUM ON SILICOSIS. An official transcript of the Third Silicosis Symposium held in connection with the Trudeau School of Tuberculosis at Saranac Lake, N. Y., June 21 to 25, 1937. A volume of 265 pages. Edited by B. E. Kuechle, Vice-president and Claims Manager, Employers Mutual Liability Insurance Company, Wausau, Wisconsin, 1937. Price: $3.00.

X-RAYS AND RADIUM IN THE TREATMENT OF DISEASES OF THE SKIN. By GEORGE M. MACKEE, M.D., Professor of Clinical Dermatology and Director of Department of Dermatology (Skin and Cancer Unit), New York Post-graduate Medical School and Hospital, Columbia University; Consulting Dermatologist, St. Luke's Hospital. Third Edition, thoroughly revised. A volume of 830 pages illustrated, with 308 engravings, 31 charts, and 2 colored plates. Published by Lea & Febiger, Philadelphia, 1938. Price: $10.00.

BOOK REVIEWS

RÖNTGENDIAGNOSTIK DER KNOCHEN- UND GELENKKRANKHEITEN (Roentgen Diagnosis of Bone and Joint Diseases). Vol. II, Knochenechinokokkose (Echinococcus Disease of Bone). By PROF. ROBERT KIENBÖCK, Vienna. A volume of 192 pages, with 19 illustrations. Published by Urban & Schwarzenberg, Berlin, 1933. Price: RM. 7.60.

In this monograph the author has summarized the main facts known to medicine regarding the infections of bone by the *Echinococcus*. After a brief discussion of the etiology of the disease, noting that there are two forms, cystic or hydatid, and the infiltrating or granulomatous form, he reviews the clinical course of the disease. He then enumerates the cases reported, with the bones involved, and summarizes these facts in the form of a table. In all, there are 86 such cases. A review of five cases seen in his own clinic is given and this is followed by a chapter on differential diagnosis.

As a reference book on this interesting but rare disease this monograph is well worth while. It is fairly well illustrated and so arranged as to be most handy as a reference book.

STUDIEN ÜBER HEREDITÄRE MULTIPLE EPIPHYSENSTÖRUNGEN (Studies of Hereditary Multiple Epiphyseal Affections). By. S. RIBBING. Acta Radiologica Supplementum XXXIV. A volume of 107 pages, with 94 illustrations. Published by Mercators Tryckeri, Helsingfors, Finland, 1937. Price: Swedish cr. 8:00.

In this monograph the author has described a peculiar type of hereditary multiple epiphyseal disturbances studied by him. The series includes 23 cases, all related. The lesions were not uniform throughout but were all epiphyseal, resembling in some instances achondroplasia and similar generalized types and in other instances osteochondritis dissecans, coxa plana, dorsal juvenile kyphosis, *et cetera*. A complete review of the literature is given.

The significance of the condition is not known but its relationship to the type of epiphyseal disturbance mentioned above offers much interesting food for thought. The patients did not have any obvious constitutional disturbance or other anomalies. These cases are illustrative of the doctrine of the "constitutionally weak epiphysis."

The monograph is well illustrated and the material well presented. The material addition to our understanding of the various peculiarities and lesions of epiphyses makes the monograph well worth while.

II Congres International de Lutte Scientifique et Sociale contre le Cancer (Second International Congress of Scientific and Social Campaign against Cancer), Brussels, Sept. 20–26, 1936, sous le Haut Patronage de S. M. le Roi et de S. M. la Reine Elisabeth. Tome II, Communications. A volume of 628 pages, with numerous figures and tables in the text. Published by Ligue Nationale Belge contre le Cancer, Brussels, 1937.

This volume, like the first, is published in the same style as the "Acta" of the International Union against Cancer and contains the communications made at the Second International Congress of Scientific and Social Campaign against Cancer, each presented in the language of the author (English, French, German, Italian, Spanish, and Russian). No paper in this volume is in Russian. There are 230 pages on the biologic and 60 on the diagnostic aspects of cancer: 192 pages are devoted to treatment by surgical, radiologic, and medical means. The various aspects of the campaign against cancer are covered in 137 pages.

It is obviously impossible to critically review this volume of several hundred papers of varying length. Even a casual perusal of the book, however, will acquaint one with the up-to-date views of the various aspects of cancer which are held by international authorities.

The 1937 Year Book of Radiology. Diagnosis edited by Charles A. Waters, M.D., Associate in Roentgenology, Johns Hopkins University; Assistant Visiting Roentgenologist, Johns Hopkins Hospital. Associate Editor, Whitmer B. Firor, M.D., Assistant in Roentgenology, Johns Hopkins University and Hospital. Therapeutics edited by Ira I. Kaplan, B.Sc., M.D., Director, Division of Cancer, Department of Hospitals, City of New York; Clinical Professor of Surgery, New York University Medical College; Director, Radiation Therapy Department, Bellevue Hospital, New York City; Director, New York City and Brooklyn Cancer Institutes; Associate Radiologist, Lenox Hill Hospital, New York City. A volume of 503 pages containing 550 illustrations. Published by The Year Book Publishers, Inc., Chicago, 1937. Price: $4.50.

In the quest for a reference volume which will be of practical value in the identification of the inevitable "puzzle" of every practice there is no more comprehensive and useful volume than the Year Book of Radiology.

The 1937 edition fully maintains the reputation of former volumes. To those whose practice embraces what might be termed "industrial roentgenology" the chapter on the osseous system is particularly interesting because of its review of fractures of various types and the most efficient methods of treatment.

The momentous question of "low back pain" is brought up to date by inclusion of articles on lumbo-sacral lesions and roentgen demonstration of rupture of the intervertebral disk into the spinal canal.

The rarer forms of bone and joint lesions are particularly well covered by a series of excellent illustrations and well chosen text.

The chapter on skull, sinuses, and mastoids is particularly interesting to those closely associated with ophthalmologists in the study of neurologic lesions.

In considerations of soft tissue lesions the essays on "painful shoulder" and the roentgen diagnosis of carcinoma of the breast are particularly interesting.

The application of kymography to the study of respiratory movements of the thoracic structures and additional uses of bronchoscopy are outstanding features of the chapter on the respiratory system. The practical application of kymographic studies of cardiac conditions will stimulate interest in this comparatively new method.

Choledochographic studies of the biliary system are comprehensively reviewed in the chapter on the gastro-intestinal system.

Articles on the value of pitressin in the elimination of intestinal gas shadows in roentgenography will have particular interest to many.

Slightly less than half of this volume is allotted to radiotherapeutics. In an introduction to this section a discussion of the cancer problem as a whole, with an excellent bibliography, affords an opportunity for intensive study. The division of this section into radiation in general medicine and also in the various specialties make it particularly valuable as a

steady reference volume for both those of wide experience and those of lesser experience.

FRACTURES AND DISLOCATIONS FOR PRACTITIONERS. By EDWIN O. GECKELER, M. D., Fellow of the American College of Surgeons, Fellow of the American Academy of Orthopedic Surgeons. A volume of 246 pages, with 213 illustrations. Published by William Wood & Company, Baltimore, 1937. Price: $4.00.

The author states in the preface that his purpose is "to condense the subject of fractures and dislocations without the omission of important details." This purpose has been well carried out and there are ready references for those wishing detailed information. The subject is condensed into 246 pages of easily readable type and is sufficiently illustrated with 213 drawings, x-ray reproductions, and photographs. Special attention is given to preparation and application of plaster of Paris.

The subject matter is introduced by a discourse on general considerations, including general directions for guidance of x-ray work in fractures through the courtesy of Dr. Roscoe C. Webb, Chief Surgeon of the Great Northern Railway Company. This speaks for the attempt to cover completely the necessities of fracture work. The author has commendably stressed the taking of early x-rays for diagnosis and the use of frequent check-up x-rays.

Criticism may be offered in the fact that, as the book is primarily for the practitioner, there is not enough attention directed toward the complications which frequently arise, such as Volkmann's ischemic contracture, early care of traumatized soft tissue and compound wounds. However, the book should be a handy reference work for the practitioner because of its clear, concise, and condensed presentation of fractures and dislocations.

RADIOPHYSIOLOGIE ET RADIOTHERAPIE (Radiophysiology and Radiotherapy): Recueil de Travaux Biologiques, Techniques et Therapeutiques (Review of Biologic Work, Technic, and Therapeutics). A periodical published from time to time, of which this is the number for March, 1937, Vol. III, fasc. 3, by the Institut du Radium of the University of Paris and the Curie Foundation. A volume of 470 pages. Price: 50 fr.

In this number are a series of articles by the different workers at the Radium Institute of Paris. The first article, by Ferroux, Regaud, and Samssownow, deals with the increase in radioresistance of seminal epithelium by the use of small doses of roentgen rays. The result of this experimental study showed that a dose of 750 roentgens, divided into ten equal fractions and given at monthly intervals over a period of ten months, diminished the radiosensitiveness of the seminal epithelium.

The second article, by Lacassagne, is a report of studies on the physiologic modifications in the ovary of adult rabbits after partial or complete destruction of the hypophysis by radon, together with the changes occurring in the hypophysis after irradiation with roentgen rays as compared with those occurring after irradiation by radon introduced into the gland. Lacassagne concludes that it is possible to destroy the hypophysis of the rabbit by introducing radon into the gland. Such destruction provokes in the ovary important and histologically characteristic alterations. Preservation of about a third of the anterior lobe of the hypophysis insures the maintenance of normal genital function, in spite of the disappearance of the remainder of the hypophysis and of the intermediate and posterior lobes. Histologic examination of incompletely destroyed hypophyses proved that the hypophyseal cells are only slightly radiosensitive. Irradiation of the hypophysis with roentgen rays confirms the resistance of this organ to irradiation.

The third article, also by Lacassagne, is a report of experiments on the radiosensitiveness of the corpus luteum and of the uterine mucosa of the rabbit by means of an artificial desiduoma. These experiments showed that strong irradiation of the ovary before the rupture of the follicles does not prevent the formation of corpora lutei which retrogress prematurely, and this is accompanied by the disappearance of cellular proliferation in the uterine mucosa. Moderate irradiation does not prevent the normal development of corpora lutei. The uterine mucosa proliferates and, in cases of unilateral irradiation, artificial desiduomas are formed on the treated side as well as on the untreated side.

The fourth article, by Ferroux and Folichon, deals with the leakage of radon from radium tubes, especially from the strong tubes employed for teleradium therapy.

The fifth article, by Loiseleur, is a report of investigations which show that irradiation

with radium or radon causes the deterioration of albuminoid substances. First the molecule is altered, especially by amidogenic groupings. To this chemical alteration is added a physico-chemical phenomenon of colloidal flocculation which requires the presence of electrolites.

The sixth article, by Regaud and Hermet, deals with evolution of epitheliomas of the uterine cervix treated by radiotherapy and not cured. This report covers 873 cases treated between 1919 and 1928. Of this number, 28.7 per cent were cured and 71.2 per cent were not cured.

The seventh article, by Baclesse, bears on roentgen therapy for advanced epitheliomas of the uterine cervix and vagina. This article contains a report of nine cured cases out of 63, and discusses at some length the technical details of irradiation.

The eighth article, by Tailhefer, is a report of end-results of surgical treatment for metastatic lymphadenopathy secondary to cancer of the tongue.

The ninth paper, by Regaud, is a discussion of the treatment of epithelioma of the rectum and anus as practised at the Radium Institute.

PETIT GUIDE DE PHYSIOTHERAPIE (Small Guide of Physiotherapy). By VINCENT PASCHETTA, Electro-radiologiste des Hôpitaux de Nice, Chef du Service d'Electro-radiologie, et du Centre de Physiotherapie de l'Hôpital Saint-Roch. A volume of 190 pages. Published by L'Expansion Scientifique Française, 23, rue du Cherche-Midi, Paris, 1937. Price: not given.

This is a small guidebook in physical therapy, stressing particularly deep roentgen-ray therapy. Chapters are devoted to the general principle of application and to the biologic properties of x-ray, radium, diathermy, the constant current, ultra-violet rays, and infra-red rays. The largest portion of the book is devoted to a dissertation on indications and technic for the use of the above-mentioned physical agents in the treatment of the following conditions: carcinomatous lesions, tuberculous lesions, inflammatory lesions, diseases of the nervous system, of the bones and joints, of the endocrine glands, of the skin, and of the digestive tract. Chapters are also included on nutritional maladies, and gynecological, urologic, otorhinolaryngologic, and circulatory diseases.

The author is most enthusiastic about deep x-ray therapy, which he recommends for many diseases. He has intentionally left out all references to other works in order to keep the book concise, as a sort of formulary on physical agents. It has been written specifically for general practitioners as a reference book. However, the reviewer questions whether it is sufficiently complete to serve this purpose fully. Some of the statements made by the author are not generally accepted in this country. For instance, the statement that "galvanization or galvano-irradiation is an excellent treatment for exophthalmic goiter and hyperthyroidism" might be questioned, as might be the statement that "diathermy is of value in treating diabetes." It can hardly be classified as a guidebook to physical therapy since it deals merely with a small phase of electrotherapy. Hydrotherapy and mechanotherapy are not discussed at all, and the description of the use of ultra-violet and infra-red rays is extremely limited. One gets the impression that the book is written by an x-ray therapist who has also some slight interest in a few other types of physical radiation. Deep roentgen-ray therapy seems to be overstressed.

On the whole, this little book does, however, contain in a concise form a considerable amount of valuable information for the physician who may be interested in a few physical agents mentioned by the author.

THE PRACTICE OF IONIZATION. By J. NEWTON DYSON, M.R.C.S. (Eng.), L.R.C.P. (London), with a Foreword by ELKIN P. CUMBERBATCH, M.A., B.M. (Oxon.), D.R.-M.E. (Camb.), F.R.C.P. A volume of 178 pages, with 9 illustrations. Published by Henry Kimpton, London, 1936. Price: $1.50.

Cumberbatch in his introduction to this small monograph mentions the need for research in the field of electrotherapy. The volume itself, however, shows very little evidence of such scientific research. The first three chapters in this small book are devoted to the physics of electricity as applied to electrotherapy The remainder of the book deals with "ionization" in the treatment of diseases. The author apparently uses the term "ionization" by choice rather than the more frequently accepted terms "iontophoresis" or "common ion transfer." Actually,

he describes the procedure commonly called "galvanization" and maintains that the polarity of the constant low voltage current is of little importance.

Many claims are made for the value of "ionization" in the treatment of diseases of the joints, muscles, and nerves, as well as diseases of the nose and ear. Rather exaggerated claims are made for the value of "ionization" in the treatment of atrophic arthritis and other ankylosing joint diseases. The author bases these claims on what he terms the "sclerolytic" action of the current. As a result of the "sclerolytic" action, rather startling results are claimed in the treatment of otosclerosis. It is contended that in many instances hearing is restored.

The work is not convincing since there are only a few case reports, no statistical studies, no controlled studies, and there is no experimental material. Likewise, there is no bibliography. Not even a theoretical presentation of the physiologic action of the constant current is presented to substantiate the many positive statements which have been made. It would seem that all of the work presented in this book should be much more thoroughly substantiated before the views of the author are given general acceptance.

ELEMENTS OF CHROMOTHERAPY, THE ADMINISTRATION OF ULTRA-VIOLET, INFRA-RED, AND LUMINOUS RAYS THROUGH COLOR FILTERS. By R. DOUGLAS HOWAT, L.R.C.P. (Edin.), L.R.C.S. (Edin.), L.R.F.P.S. (Glas.), with a Foreword by SIR HENRY GAUVAIN, M.D., M.Chir., F.R.C.S. A volume of 106 pages, with 20 illustrations. Published by The Actinic Press, Ltd., London, 1938. Price: 8/6d.

This small monograph, as the title suggests, describes the use of visible and invisible light rays through colored filters. There are chapters on history, physics, erythema, action on bacteria, filters, lamps, technic, and clinical observations.

The work discusses chiefly the use of visible light through colored filters and makes many extravagant claims for the value of such radiations. Since no less an authority than W. W. Coblenz, of the Washington Bureau of Standards and member of the Council on Physical Therapy of the American Medical Association, has stated, "If the rays in the visible spectrum have any special therapeutic action, it remains to be determined," and since practically all modern experts in light therapy have considered that the use of colored lights can have no other effect than a psychic one, this text was reviewed carefully to see whether there was any new material in it which would warrant the claim by Doctor Howat that "chromotherapy was of value."

When one reads his chapter on the action of color rays on bacteria, at first glance, he seems to present a rather imposing array of direct quotations from other writers to support his views. On more careful check-up with the brief bibliography that he has appended at the end of the book, it was found that a number of his sources of reference were not given and that those which were given were extremely antiquated. For instance, in this chapter, the references given were dated, respectively, 1877, 1904, 1858, 1883, 1879, 1889, and 1903. Such antiquated material, all of it over twenty-five years of age, of course merits no consideration in a modern textbook. A check of the bibliography shows that of the forty-five references for which dates are given, twenty-one are over twenty-five years old. The author bases his contentions on such obsolete material and on twenty-five sketchy case reports of a highly unscientific nature. Typical of these case reports is the first one describing treatment of "acidity" by application of a "red filter over epigastrium for fifteen minutes." It is reported that after a dozen treatments, the patient "was absolutely free from symptoms and declared that she had never felt so fit." Need more be said concerning this volume?

The Reviewer is rather amazed that a medical man could write such an unscientific text, and that one so famed as Sir Henry Gauvain should be willing to lend his name to its publication. This text cannot be recommended.

LA VÉSICULE BILIARE ET SES VOIES D'EXCRETION (The Gall Bladder and Biliary Ducts). By M. CHIRAY, J. PAVEL, and A. LOMON. A volume of 863 pages. Second Edition. Published by Masson et Cie, Paris, 1936. Price: 120 fr.

The second edition of this standard work enlarges and brings up to date the material

offered in the first edition. Among the valuable features of this work are: a chapter on methods of examination of the gall bladder and bile passages, including an excellent account of cholecystography by Lomon, and a section devoted to a detailed and excellent discussion of the semeiology of cholecystic disease. In the section devoted to diseases of the gall bladder a good deal of attention is paid to biliary stasis dependent on functional defects in evacuation. There are many American clinicians who may not agree with some of the theories advanced here, but the manner of presentation is, in general, critical and cautious. The chapter on medical treatment lays a great deal of stress on the advantages of duodenal drainage.

The work is almost encyclopedic in its completeness and gives every evidence of the great experience of the authors, who have been among the foremost French investigators in this field. There is an excellent bibliography at the end of each section containing practically all the literature on the subject subsequent to 1926. The work is perhaps somewhat too detailed for the general practitioner, but for those particularly interested in the diagnosis and treatment of cholecystic and biliary disease it may be recommended without qualification. The book is well illustrated and there are numerous colored plates.

ZEHN VORLESUNGEN UBER KYMOGRAPHIE (Ten Lectures on Kymography). By Dr. med. PLEIKART STUMPF, Associate Professor in the University of Munich. A volume of 112 pages, with 80 illustrations and a grid to demonstrate motion. Published by Georg Thieme, Leipzig, 1937. Price: 8.70 RM.

This monograph contains ten lectures by the well-known pioneer in kymography and is intended to furnish the beginner with an introduction to the subject. The text is clearly written and covers sufficient ground to give an excellent foundation for further and more detailed studies. The illustrations are very instructive, showing the reader that by using a grid provided on a sheet of celluloid which can be moved across some of the reproduced kymograms, the careful observer—after a little practice—can obtain an effect very close to the actual appearance on the fluoroscopic screen. At the end of the book factors for the exposure technic with a 4-valve-tube-rectified machine are given. The author has also compiled data on the normal and pathologic picture of the heart, stomach, and genitourinary tract, as well as the mechanism of respiration and swallowing. No bibliography is appended, but the reader is referred to the very complete review of the literature in the book published by the author in collaboration with Weber and Weltz in 1936. As an introduction to kymography this monograph is heartily recommended.

ABSTRACTS OF CURRENT LITERATURE

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THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

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S. Richard Beatty, M.D., of Madison, Wis.
G. E. Burch, M.D., of New Orleans, La.
J. E. Habbe, M.D., of Milwaukee, Wis.
Hans W. Hefke, M.D., of Milwaukee, Wis.
L. G. Jacobs, M.D., of Madison, Wis.
E. T. Leddy, M.D., of Rochester, Minn.
John M. Miles, M.D., of Houston, Tex.
E. A. Pohle, M.D., Ph.D., of Madison. Wis.
J. C. Rodick, M.D., of New Orleans, La.
W. A. Sodeman, M.D., of New Orleans, La.

ABSTRACTS IN THIS ISSUE LISTED ALPHABETICALLY BY AUTHORS

HERNIA

The Roentgen Diagnosis of Intra-abdominal Hernia. Fay K. Alexander. Am. Jour. Roentgenol. and Rad. Ther., July, 1937, **38,** 92–101.

Intra-abdominal hernia, which term is preferred to such terminology as duodenal, paraduodenal, descending mesocolon, ascending colon hernia, etc., is probably present more frequently than is supposed. The diagnosis, which can be made solely by roentgen examination, requires a longer study of the small bowel than is commonly made, for the meal must be followed through at least the proximal half of the jejunum to see the abnormal course, the close approximation and apparent binding together of the loops as if held in a sac. In the five patients reported, the distal duodenum and duodeno-jejunal junction ran an abnormal course. Post-operative adhesions and congenital short mesentery may produce similar findings. Abdominal pain exaggerated by exertion, erect posture, or eating, and relieved by retching, or recumbent posture, or smaller meals, or food with but slight roughage, should bring this condition to mind. The etiology appears to be congenital rather than acquired.

S. M. Atkins, M.D.

KELOIDS

Radiation Therapy of Keloids. W. Baensch. Strahlentherapie, 1937, **60,** 204.

The author relates his technic of treating keloids. He uses radium needles of 1, 2, and 4 cm. length containing 1, 2, and 4 mg., respectively. They are filtered through 0.5 Pt. Sometimes the insertion of these needles is combined with surface applications at 1 cm. distance and according to the size of the lesion 80–800 mg.-hr. are given. Before developing the radium technic roentgen rays were administered in doses of 300–500 r filtered through 4 mm. Al. A review of 58 treated cases showed that 36 were subjected to radium therapy; thirteen showed excellent response, eleven were considerably improved, six improved, and six did not respond. Twenty-two keloids were treated by roentgen rays; eight of these showed excellent results, four were considerably improved, three improved, and seven did not respond. The author concludes that the combined radium implantation and surface application is the most promising method.

Ernst A. Pohle, M.D., Ph.D.

THE KIDNEYS

The Nature of Certain Kidney Tumors. Eugene R. Whitmore. Southern Med. Jour., December, 1937, **30,** 1149–1157.

Cases illustrative of epithelial and connective tissue tumors of the kidney are presented. One of these tumors, microscopically hypernephroid, has metastases, some of which are hypernephroid and some sarcomatous with no adrenal cortical hormone in either the primary tumor or its metastases.

The author's explanation for the dual nature of the metastases is that the cells of the kidney, developing from mesoderm, retain their potentialities to form both epithelium and connective tissue, one potentiality being dominant, the other recessive. In neoplasia both potentialities may be exercised, so metastases may be partly hypernephroid and partly sarcomatous.

With this explanation it is not necessary to assume misplaced cortical cells as the origin of a primary epithelial tumor or "sarcomatous degeneration" of the stroma to account for sarcoma metastases from such a tumor.

John M. Miles, M.D.

The Roentgen Investigation of the Operatively Delivered Kidney. H. Hensser. Schweiz. med. Wchnschr., July 10, 1937, **67,** 630–632.

The author feels that the standard methods of investigating the kidney in cases of stone are not entirely satisfactory, and that the taking of films on the operatively delivered kidney will give more information. Not only can the number and size, but also the position, type, and build be determined. He describes the technic in some detail. The waterproof sterilizable bags used are closed with zippers. The method can also be used to obtain pyelograms at the time of operation, either intravenous or retrograde filling of the pelvis, or filling by direct puncture, being employed. The method is stated to be easy of application.

L. G. Jacobs, M.D.

Solitary Cysts of the Kidney. A. Ravich and S. M. Turkeltaub. Urol. and Cutan. Rev., April, 1937, **41,** 260–264. (Reprinted by permission from British Med. Jour., June 26, 1937, p. 102 of Epitome of Current Medical Literature.)

The authors report seven cases in patients aged from 41 to 69, of whom four were men and three women. In five instances there were definite associated pathological lesions which may have contributed to the formation of the renal cysts. In three cases nephrolithiasis with moderate infection was present, and in one case an infiltrating papillary carcinoma of the ureter with secondary hydronephrosis was found. The fifth patient had chronic nephritis with hypertension, arteriosclerosis, and diabetes, and another case had a renal calculus on the opposite side. The present series, therefore, supports Hepler's view that any lesion, local or constitutional, capable of causing tubular occlusion and interference with blood supply, may be responsible for the formation of these cysts. The lesion in the present cases varied in size from that of a small tangerine orange to that of a large sac containing over 1,500 c.c. of fluid. In all the cases the lower pole of the kidney was involved. In six cases the anterior and in two the posterior surface were the sites of origin. All the cases were histologically benign. Five of the cysts contained straw-colored fluid and two hemorrhagic fluid. No special symptoms were encountered, and most of the patients sought advice for an associated lesion. Diagnosis was made by x-ray examination,

which showed a globular mass causing a disfigured and irregular appearance of the kidney. Treatment consisted in complete enucleation of the cyst. Nephrectomy was never necessary.

THE KNEE JOINT

The Roentgen Diagnosis of the Patella. C. Zweifel. Röntgenpraxis, May, 1937, **9**, 313–318.

Routine anteroposterior and lateral films of the patella often do not allow an adequate visualization. It may be difficult at times to determine the presence of a small fracture or other easily overlooked pathology. The author recommends a technic which was devised by Kuchendorf, but which has been forgotten by most radiologists. It allows the projection of four-fifths of the patella in its anteroposterior aspect away from the condyles of the femur. The film is taken in posteroanterior direction, the knee is slightly flexed and rotated externally. The patella is subluxated in a lateral direction by manual pressure. The tube is angled from 15 to 20 degrees in a lateral direction. Five cases are reported in which this special technic allowed a much improved visualization of the patella and a more accurate diagnosis.

HANS W. HEFKE, M.D.

Ten Cases of Injuries to Crucial Ligaments in the Knee Joint Operated on and Reported. I. Palmer. Acta chir. Scandinav., 1937, **79**, 391–405. (Reprinted by permission from British Med. Jour., Oct. 30, 1937, p. 65 of Epitome of Current Medical Literature.)

Palmer considers that injuries to the crucial ligaments have become more common of recent years on account of the increased number of athletic and traffic accidents. It has been found that rotation and abduction or adduction trauma may give rise to injuries to the crucial ligaments in combination with other lesions. The diagnostic features are hyperextension, increased passive inward rotation, and the drawer sign, namely, ability to shift the tibia backwards and forwards on the femur with the knee flexed. X-ray examination is often useful as an aid to diagnosis. Injuries of the crucial ligaments include overstretching, threadbareness, total or partial rupture of the ligamentous substance, and rupture at the femoral or tibial attachment with or without the detachment of bony fragments. Early operative treatment is recommended, as in cases of recent injury to the crucial ligaments direct suture may be possible. In later or chronic cases some plastic operation with tendons or fascia is necessary. In cases in which operation has been delayed subluxation may take place, with the development of a secondary arthritis deformans, which renders operative treatment impossible. In these cases an artificial jointed knee-cap helps the patient. The operative procedure is described, and ten cases are reported, in most of which recovery was complete after treatment by either suture or grafting.

Injuries of the Semilunar Cartilage. H. Prinz. Beitr. z. klin Chir., April 28, 1937, **165**, 337–375. (Reprinted by permission from British Med. Jour., July 10, 1937, p. 9 of Epitome of Current Medical Literature.)

In the experience of the author these injuries more commonly affect the internal cartilage in the male sex, and are to be diagnosed chiefly from signs of resistance to complete extension and from tenderness between the femur and the tibia when the leg is externally rotated on the thigh with the knee flexed. Each of these symptoms is occasionally absent in spite of a torn cartilage, and each may sometimes be produced in the absence of a tear by the impaction of swollen synovial fringes or by a free foreign body. Steinmann's sign (the shifting—backwards during flexion and forwards during extension of the knee—of the tender point) can sometimes be elicited. The presence or absence of effusion is not important in diagnosis, and a characteristic history is not always obtainable.

Ordinary roentgenography is seldom helpful, but in doubtful cases Böhm's method of roentgenography after intra-articular injection of from 3 to 4 c.c. of aqueous uroselectan B may be decisive. Endoscopy of the joint is more dangerous than surgical exploration, and is unjustifiable. At Konjetzny's clinic, operation is preferred to conservative treatment for persistent or recurrent derangement. Although the injured and torn parts of the cartilage are removed, its capsular zone's capacity for regeneration is such that it may be left behind when possible, unless the patient is engaged in heavy manual work.

Prinz discusses fully the etiology of the tearing of the semilunar cartilage. In all but three out of 15 cases microscopical examination showed chronic degenerative or inflammatory changes, which some German and Swiss writers have regarded as primarily causative, trauma playing an unimportant part. Conclusions drawn from histological examination alone, however, are deceptive; it is certain that in a large majority of cases direct or indirect trauma is the chief etiologic factor.

LEUKEMIA

Chronic Myelogenous Leukemia: Observations before and during Remissions Induced by Solution of Potassium Arsenite and by Roentgen Therapy, with Particular Reference to Bone Marrow. D. J. Stephens. Am. Jour. Med. Sci., July, 1937, **194**, 25–34.

The author points out that, although the similarity of the therapeutic response of chronic myelogenous leukemia to roentgen therapy and to a solution of potassium arsenite is known, detailed studies of the bone marrow before and after treatment are not available. He reports observations in two patients, one treated with arsenic, the other with roentgen therapy, of the peripheral blood, bone marrow, oxygen consumption, and nitrogen balance. In each instance treatment was followed by clinical improvement, reduction in total leukocytic count, especially the immature forms, improvement in anemia, return of oxygen consumption to a normal level, and changes in the bone marrow.

In both patients the gray hyperplastic marrow was replaced by a hypocellular fibrotic marrow. Roentgen therapy was followed by a marked increase in the nitrogen excretion; potassium arsenite was not.

W. A. SODEMAN, M.D.

Qualitative and Quantitative Changes in Thrombocytes in Chronic Myelogenous Leukemia under the Influence of Roentgen Rays. J. Arneth. Strahlentherapie, 1937, **59**, 104.

The author studied the behavior of the blood platelets in myelogenous leukemia before, during, and after roentgen therapy. He found that the blood platelets may be increased but are also occasionally found decreased. During roentgen therapy in patients with myelogenous leukemia they are subject to great variations; a marked drop may well be a contra-indication to further radiation therapy. He discusses at length the relation between the changes in the blood platelets and the left and right shift in the leukocytes. Great reduction in the number of the platelets during treatment may be followed by hemorrhagic diathesis and lead to death. The variations in the platelets cannot be explained by a direct effect of roentgen rays on these cells.

ERNST A. POHLE, M.D., Ph.D.

THE LIVER

Calcified Hydatid Cyst of the Liver. Toupet, Moreau, Darıaux, and Cassan. Bull. et Mém. Soc. Radiol. Méd. de France, February, 1937, **25**, 115–117.

A hydatid cyst with calcification of the wall was demonstrated roentgenologically to arise from the liver. The diagnosis was confirmed by operation.

S. RICHARD BEATTY, M.D.

LIGHT THERAPY

The Advantages of Sensitization to Light in Treatment with Natural and Artificial Sources of Light. H. Jausion. Strahlentherapie, 1937, **60**, 82.

The author relates his experience with sensitizing substances administered orally, rectally, and intravenously. He used methylene blue, eosin, and Hofmann's violet. Especially in countries with a low percentage of sunny days this procedure should be of value.

ERNST A. POHLE, M.D., Ph.D.

THE LUNGS

The Diagnosis of Cavity. Klaus Glaum. München. med. Wchnschr., Sept. 24, 1937, **84**, 1539–1541.

The author believes that in diagnosing cavity, a correlation between clinica and roentgen findings is essential. He illustrates this view with a well-chosen case report showing how neglect of the clinical aspects may lead one astray.

L. G. JACOBS, M.D.

Contribution to the Roentgen Therapy of Metastatic Carcinoma of the Lungs. Emil Füssl. Röntgenpraxis, March, 1937, **9**, 184–190.

Persistent and well planned series of roentgen treatments are able to achieve marked subjective improvement in some cases of metastatic cancer of the lungs. It may even be possible to expect a cure in rare cases. It is the author's opinion that treatment should not be stopped after the metastases have regressed, but that it should be continued until the extreme limits of tolerance have been reached.

A case of cancer of the thyroid is reported which showed lung metastases eight years after surgical removal of the primary tumor. The lungs were treated by massive doses (2,400 r to each of four fields). Five such series were given and after their completion a definite regression and almost complete disappearance of the large metastatic nodules were noted on roentgenograms of the chest. Three more similar series were administered during the next two years. In the course of four years, 20,000 roentgens were given to the lungs. The patient died from metastases to the brain. The autopsy showed comparatively little involvement of the lungs.

HANS W. HEFKE, M.D.

The Anatomic Value of the Sharp Interlobar Projection of the Lung. Luigi Bargi. Arch. di Radiologia, 1937, **15**, 177–197.

The author discusses the diagnostic importance of the capillary interlobar lines and illustrates it by reproductions of roentgenograms. He shows how they may be missed by the incorrect angle of incidence and the changes they undergo when taken at the correct projection. The line is of importance in the diagnosis of interlobar pleurisy.

E. T. LEDDY, M.D.

Prognosis of Roentgen Therapy in Actinomycosis of the Lungs. B. Kuhlmann. Strahlentherapie, 1937, **60**, 476.

The author reports a case of a man, 50 years of age, who developed a cough in 1931, with a good deal of expectoration and sharp pain in the right chest. Examination of the sputum was negative for tuberculosis. A roentgenogram of the chest showed a diffuse radiopacity in the middle part of the upper right chest extending into the mediastinum. Re-examination of the sputum finally showed actinomycoses. (The patient reported that he had dressed a deer and noticed a tumor on the jaw: in all probability this constituted the source of infection.) In September, 1931, he received x-ray therapy over the upper right chest. On four successive days 200 r were given over each area. The

series was repeated in four weeks with good improvement. Three and a half months afterward the chest was practically negative. Two years later, after numerous colds in the interim, the disease recurred and now showed a new focus of about apple-size in the right hilum. Treatment was given again but in spite of it the condition of the patient grew worse and apparently he developed an involvement of the upper thoracic spine. This area was also treated and in January, 1936, he was completely free from symptoms and has remained so until July, 1937. The author emphasizes that apparently early roentgen therapy, combined with potassium iodide and gold medication, is very effective in the treatment of actinomycosis.

ERNST A. POHLE, M.D., Ph.D.

Roentgenological Observations in a "Honey-comb" Lung. H. V. Braunbehrens and D. Pilch. Röntgenpraxis, May, 1937, **9**, 297–304.

The diagnosis of honey-comb lung or congenital cystic disease of the lungs has been made much more frequently during the last few years than before the general use of roentgen rays. Ring shadows, sometimes with a fluid level, are seen in lung areas which usually are emphysematous. This system of cavities or cysts is usually in direct connection with the bronchial tree. The mediastinum may be displaced; occasionally a pneumothorax is present. Bronchography may be used for confirmation in doubtful cases.

The case reported by the authors showed all the classical signs in the roentgen films. They were limited to the right, middle, and lower lobes. A bronchography showed multiple cavities; it proved that one dealt with a so-called open cystic lung.

Tomographic examination seemed to indicate an absence or poor development of the blood vessels in the diseased area. The kymogram showed a marked inspiratory shift of the mediastinum toward the right, indicating that the right lung was practically useless as far as vital capacity was concerned. The pneumothorax, found at the first examination, was apparently one of the causes of the dyspnea, which improved after the pneumothorax became smaller.

HANS W. HEFKE, M.D.

The Diagnosis of "Butterfly-like" Shadows of the Lungs. J. Monauni. Röntgenpraxis, January, 1938, **10**, 1–4.

This contribution to the differential diagnosis of butterfly-like lung shadows tries to explain its anatomical and pathological basis. The term is meant to indicate a bilateral hilar wing-like infiltration.

In the case reported by the author this appearance was due to a tuberculosis which was disseminated mostly in the region of the upper interlobar spaces in both lungs. The differential diagnosis between the different types of tuberculosis and Boeck's sarcoid is discussed. The question is raised if lung infiltration of the described type may not be distributed in or around the interlobar spaces in other diseases of the lungs also. Special roentgenologic studies, for instance Fleischner's position, should be able to prove or disprove such localization of lung lesions.

HANS W. HEFKE, M.D.

LYMPHOGRANULOMA

A Case of Diabetes Insipidus Due to Lymphogranuloma. W. Falta and O. Spitzenberger. Strahlentherapie, 1937, **60**, 385.

The authors report a case of Hodgkin's disease with multiple glandular involvement and a mediastinal mass. After some initial response to roentgen therapy, the patient developed diabetes insipidus. Roentgenograms of the skull showed decalcification of the posterior clinoid process. Assuming a lymphogranulomatous focus in the hypophysis, the gland was subjected to radiation but without striking response. Autopsy verified the diagnosis.

ERNST A. POHLE, M.D., Ph.D.

Roentgen Therapy in Subacute Inguinal Lymphogranulomatosis of Nicolas and Favre (The Fourth Venereal Disease). Carlo Guarini. Arch. di Radiol., 1937, **8**, 32–36.

Guarini has treated eleven cases of this lesion between 1922 and 1936, and obtained good results in eight of them. He uses the following technic: 180 kv., 3 ma., 40 cm. T.S.D., 0.5 mm. zinc + 2 mm. aluminum, a field about 10 × 15 cm. (to include the lesion). He gives from 200 to 300 r per treatment every four or five days and uses from four to twelve treatments according to the clinical indications. He thinks that x-ray treatment should be more commonly used in the treatment of this disease.

E. T. LEDDY, M.D.

MENINGITIS, EPIDEMIC

Surprising Response of Epidemic Meningitis to Roentgen Rays. H. Schüle. Strahlentherapie, 1937, **60**, 318.

Several years ago roentgen therapy was recommended for cases of tuberculous meningitis, but controls on a large material did not prove it to be effective. Little is known, however, regarding the response of epidemic meningitis to radiation therapy. The author reports such a case of a 20-year-old male who was treated over the left temporal area with 165 r (180 kv., 0.5 mm. Cu). Within 24 hours there was a striking improvement in the condition of the patient so that no further treatment was given. Recovery followed and about five weeks after the treatment the patient could be discharged. Although this is only a single observation, the author feels encouraged by his experience to give this method a trial.

ERNST A. POHLE, M.D., Ph.D.

METAPLASIA

Ossification of the Achilles Tendon. H. Hufnagl. München. med. Wchnschr., Sept. 3, 1937, **84,** 1410.

The author classifies tendinous ossifications into three groups: first, ossification in ligamentous attachments; second, those in tendinous attachments of muscles, and third, those within the tendon itself. The first two groups are easily explained by periosteal overgrowth or by traumatic tearing with ossification. The third is less easily explained, previous writings differing in their explanation. Metaplasia, or ossification in a connective tissue altered by inflammatory changes, will summarize them. A case report supports the metaplastic theory. The patient developed this ossification after repeated trauma, and microscopic examination of the excised specimen showed increase of intra-tendinous connective tissue with hyaline swelling, atrophy of the tendon fibers, punctate calcification of the connective tissue, and metaplasia into cartilage and bone. A review of another such case (of Höring) fits in with this opinion.

L. G. Jacobs, M.D.

NERVOUS SYSTEM

Which of the Methods of Administering Roentgen Rays is Most Suitable in the Treatment of Diseases of the Central Nervous System? M. Sgalitzer. Strahlentherapie, 1937, **58,** 571.

The author considers the fractional dose method as most suitable in the treatment of diseases of the central nervous system by roentgen rays. He recommends using four to five fields whenever possible and starting the series with a test dose of 50 r. If there are no severe reactions, the dose may be increased up to 150 r per area. Medium high total doses seem advisable, and the best results have been obtained, in his experience, when operation was combined with post-operative x-ray therapy.

Ernst A. Pohle, M.D., Ph.D.

ORBITAL REGION

Roentgenological Diagnostics of the Foramen Opticum. B. J. Farberov. Acta Radiologica, August, 1937, **18,** 594–606.

Farberov studied the variations in the normal and abnormal optic foramen; he described the technic he employed and found to be satisfactory. From a study of over 400 patients, most of which had ocular complaints, the author found no differences in the optic foramen which could be attributed to sex or race. Minimum diameters of 2.8 mm. and maximum diameters of 6.0 to 6.5 mm. were considered to be the normal range. When the two diameters did not differ by more than one-third and the patient was symptom-free, the author did not consider the findings abnormal. Thinning of the contour of the foramen was not always pathological. After four to five years of age the optic foramen does not change in size or shape. Tumors of the optic nerve produced large (three to four times the normal size) and thin optic channels. Small tumors may produce very little change. Unilateral or bilateral constriction of the foramen was found in five patients (one with syphilis, one with Crouzon's disease, and the etiology remained unknown for the others). Osteoplastic metastasis from a distant primary focus may, in rare cases, produce constriction of the channel-diameter. Examination of the foramen opticum is profitable in studying the growth of osteomas of the orbital wall or air cavities. The author in analyzing his data grouped the alterations found in the foramen opticum, the adjoining orbital districts and in the paranasal sinuses as follows:

(*A*) *Alterations of the form of foramen opticum due to*
- (1) congenital deformation;
- (2) acquired deformation.

(*B*) *Alterations of the dimensions of the foramen opticum:*
- (1) enlargement of the channel lumen (a proportional one with retention of the original form, and a non-proportional one without alteration of the original form);
- (2) decrease of the dimensions (a circular and non-proportional flattening of one diameter).

(*C*) *Alteration of the outline of the foramen opticum:*
- (1) thinning;
- (2) partial or general thickening;
- (3) breaking up of the continuity of the outline;
- (4) sulcus in the floor for the arteria ophthalmica.

(*D*) *Complete destruction of the foramen opticum.*

(*E*) *Alterations inside the channel lumen—horizontal calcification strip separating the lower smaller part of foramen opticum for arteria ophthalmica.* (In our material we discovered in one instance also a vertical calcification strip inside the channel lumen; no patho-histological examination followed. This case represented optic nerve atrophy.)

(*F*) *Alterations of the small wing of the ossis sphenoidalis:*
- (1) general thickening and condensation of the whole wing;
- (2) air cavities inside the processus clinoideus anterior.

(*G*) *Alterations of the sinus sphenoidalis and of the posterior cells of the sinus ethmoidalis of the same side* (also in Highmore cavity and the sinus frontalis):
- (1) diffuse shading of the cavities;
- (2) sclerosed cavities;
- (3) distinctly confined shadows of tumors of rhinogenic origin.

(*H*) *Alterations of the external orbital wall:*
- (1) thickening, hyperostosis;
- (2) slit-shaped and channel-shaped defects;
- (3) breaks in the bone integrity (fissures, fractures).

All of these enumerated alterations were observed in various combinations. In approximately one-third of all cases, examination of the foramen opticum was helpful for the discernment and the minute definition of the character and the spreading of the various diseases of the orbital region. The examination was particularly serviceable in cases of retrobulbar neuritis, choked disks, optic nerve atrophy, exophthalmos,

trauma in the orbital region, and some indistinct visual disturbances. This examination was mostly useful in cases of unilateral lesions.

G. E. BURCH, M.D.

THE PANCREAS

Changes in the Pancreas Following Roentgen Irradiation. J. Seino. Strahlentherapie, 1937, **58,** 449.

The author studied the relation between the condition of the islands of Langerhans and the sugar metabolism. In order to produce hypertrophy of the islands he used ligation of the pancreatic ducts, partial removal of the glands, roentgen irradiation, and chronic starvation of the rabbits. The assimilation of sugar is not as much disturbed following irradiation as after partial extirpation of the gland or ligation. However, there was definite histologic evidence of injury of the pancreatic tissue. No hypertrophy or hyperplasia of the islands was seen in the irradiated part of the pancreas. No stimulative effect of roentgen rays could be detected. In animals with hypoglycemia the islands were not hypertrophied or hyperplastic but the sugar metabolism was disturbed. The author concludes from his experiments that the pancreas of the rabbit can definitely be injured by roentgen irradiation.

ERNST A. POHLE, M.D., Ph.D.

PEPTIC ULCER

Anomalies of Pain in the Gastro-duodenal Ulcer. P. Savy, R. Froment, A. Chapuy, and M. Jeune. Presse med., April 21, 1937, **45,** 609, 610. (Reprinted by permission from British Med. Jour., July 10, 1937, p. 5 of Epitome of Current Medical Literature.)

The authors describe the common signs and symptoms of gastro-duodenal ulcer, including pain in the epigastrium with dorsal or thoracic radiation, which appears some time after meals and is relieved by the ingestion of food. Pain usually lasts for about three weeks, with intervals of remission for several months. As a result of observation in 215 cases of peptic ulcer certain anomalies have been noted. In some cases the pain may be felt in an unusual region, such as the dorso-lumbar, and instances are given in which a duodenal ulcer caused pain of the pseudo-nephritic type or pain in the left lumbar area. Hypogastric and pseudo-intestinal types were also seen, in the first of which the pain started in the left iliac fossa and in the second in the appendicular region. In other instances the pain originated in the thoracic region before extending to the abdomen.

It was noticed that in certain cases pain was not relieved by eating, and on occasion it occurred soon or immediately after taking food. Anomalies regarding the duration of the attacks were also observed; two cases are quoted in which they lasted only three days, and another in which a period of quiescence lasting for 18 months was followed by pain several times a day with an interval of only one or two days between.

Other anomalies which may lead to a mistaken diagnosis include raised temperature, vomiting, and pain simulating that of cholecystitis. In those cases which do not present the typical symptoms of peptic ulcer roentgenography is necessary in order that a correct diagnosis may be made.

PHYSICAL THERAPY

Specific Action of Ultra-short Waves. W. A. G. van Everdingen. Acta Radiologica, August, 1937, **18,** 543–546.

The rise of temperature of the irradiated body depends upon many factors, some of which cannot be determined in the living tissue. The specific resistance of the object, the mass of the object, the dielectric constant, the heat conductivity, and the emissivity of the body are important ones. The cooling effect of the blood in the living animal is an integrating factor.

The author looks upon the problem from two different angles: First, the action of ultra-short waves may be explained upon the principle founded on the change of the dielectricum when living tissue is brought into the condensator-field of a high frequency circuit, and, second, he considers the importance that may be attached to the dipole theory of Debye.

G. E. BURCH, M.D.

PNEUMONIA

Roentgen Rays in the Diagnosis and Treatment of Pneumonia. Eugene V. Powell. Texas St. Jour. Med., October, 1937, **33,** 427–431.

The author has for four and one-half years employed x-ray therapy in 103 cases of lobar pneumonia with a mortality under 5 per cent. The only contra-indication is a definite leukopenia such as is seen in post-influenzal pneumonias.

The technic consists of from 250 to 350 roentgens of 0.3 Ångstrom unit effective radiation given over the involved portion of the lung, repeated over an opposite skin area in 48 hours if the temperature does not return to normal.

JOHN M. MILES, M.D.

X-ray Therapy in the Treatment of Pneumonia. F. T. McIntire and Jerome H. Smith. Texas St. Jour. Med., October, 1937, **33,** 422–426.

The authors review 38 cases of pneumonia which they treated with x-ray, with a corrected mortality of 13.7 per cent for the cases of bronchopneumonia and 9.1 per cent for the cases of lobar pneumonia. Dosage employed was 110 r measured with back-scatter, using 140 kilovolts through a 20 cm. portal, and repeating this dose in forty-eight hours if necessary.

They believe x-ray therapy is of value in all types of pneumonia exhibiting an adequate white blood count, except in very early cases of bronchopneumonia, with considerable congestion or a minimum consolidation.

JOHN M. MILES, M.D.

PNEUMOPERITONEUM

Artificial Pneumoperitoneum. Aubry and Bertrand-Guy. Bull. et Mém. Soc. Radiol. Méd. de France, February, 1937, **25,** 130–133.

Artificial pneumoperitoneum is a useful diagnostic procedure which makes possible the detection of pathology not demonstrable by ordinary roentgenograms. It has been, in the authors' experience, innocuous. It is especially available in cases that have had ascites. Three cases are presented demonstrating its value in the diagnosis of intraperitoneal adhesions.

S. Richard Beatty, M.D.

PROTECTION

An Attempt to Carry Out Fitness Tests before Working with Roentgen Rays. M. Sgalitzer and E. Ungar. Strahlentherapie, 1937, **58,** 701.

The authors discuss a problem of great interest to the radiologist, namely, the testing of persons who intend to enter an occupation which exposes them to x-rays or radium. They studied, first, the behavior of normal adults to a general body exposure given at 1.3 meter distance with 170 kv., 0.5 mm. Cu + 1 mm. Al, and a dose of 15 r over the anterior and posterior aspects. After certain normal figures have been established as to the reactions of the leukocytes, they propose to use these as the basis of a test. Anyone whose leukocytes show a higher susceptibility to roentgen rays should be advised accordingly.

Ernst A. Pohle, M.D., Ph.D.

Measurements of Protection against Radiation. K. G. Zimmer. Strahlentherapie, 1937, **59,** 671.

Adequate protection in radiological departments is very important. The author undertook, therefore, a series of measurements to determine the amount of radiation present in places where the personnel would be exposed to it. He describes the apparatus which consisted of a condenser ionization chamber and an electrometer. The technic of the measurements is outlined in detail. He demonstrates that systematic tests often reveal inadequate protection and consequently excessive exposure for the operator.

Ernst A. Pohle, M.D., Ph.D.

RADIATION

Late Results of the Fractional Protracted Dose Method. J. Borak. Strahlentherapie, 1937, **58,** 560.

The author compares simple fractionation with protracted fractionation in roentgen therapy of malignant disease. After an analysis of his clinical observations, he concludes that both methods are equal from a therapeutic standpoint. He cannot see any superiority of the fractionation with very small intensities. Furthermore, the economical factor is so important as to deserve serious consideration.

Ernst A. Pohle, M.D., Ph.D.

Development, Principles, and Biological Foundations of Methods of Radiation Therapy. G. Schwarz. Strahlentherapie, 1937, **58,** 499.

This is a very complete historical sketch of the development of radiation therapy, beginning with the first therapeutic attempt in 1896 up to the present time. Because of the enormous wealth of information contained in this article it does not lend itself to abstracting but is recommended for study in the original (118 references to the literature).

Ernst A. Pohle, M.D., Ph.D.

Cell Permeability and Effect of Irradiation. F. Ellinger. Strahlentherapie, 1937, **58,** 464.

In order to study the physiologic effect of ultra-violet light the author exposed collodion membranes to the radiation emitted by a quartz mercury vapor lamp for 15 minutes at 25 cm. distance. Methyl-orange was chosen as indicator. He found that there is a definite increase in the permeability of the membrane after irradiation, a phenomenon which had been observed on living cells. This effect of irradiation cannot be regarded, therefore, as a characteristic property of living substance but may be explained by changes of the potential in the membrane.

Ernst A Pohle, M.D., Ph.D.

The Simple Fractional Dose Method in Radiation Therapy. E. Weber. Strahlentherapie, 1937, **58,** 557.

For economic reasons the author developed a modification of the Coutard method, retaining the protraction which, in his opinion, is the principal factor. Technic: 180 kv., 4 ma., 0.5 mm. Cu + 1 mm. Al, 30–35 cm. F.S.D., 25 r/min. In undifferentiated types of carcinoma the duration of treatment amounts to 20 days and in the differentiated types to about 45 days. His experience, extending now over a period of five years, tends to show that with the modified method the skin and epithelial reactions are the same as with the original method of Coutard. While good results were obtained in carcinoma of pharynx, larynx, and mouth, little benefit was seen in inoperable carcinoma of the thyroid, the esophagus, the lung, and recurrent carcinoma of the breast.

Ernst A. Pohle, M.D., Ph.D.

The Saturation Method in the Treatment of Malignant Disease, with Special Consideration of Holfelder's Modification. H. Holfelder. Strahlentherapie, 1937, **58,** 528.

The author discusses the principles of the saturation method as proposed originally by Kingery and Pfahler. The correction of the figures given by Pfahler based on Reisner's investigations are explained. The Coutard method is compared with the treatment technic developed at the author's clinic. Because his results have been excellent, Holfelder sees no reason for giving up

his own technic. As an example, he quotes that in a patient who receives six or eight fields the daily dose per area is from 300 to 330 r (in air). In the case of six fields, two areas are given each day for a period of three days, and beginning the fourth day one field is given daily. After three weeks one field is given every other day. He believes that this method uses fully the selective effect of radiation as based on the difference in cumulation in normal and diseased tissue.

ERNST A. POHLE, M.D., Ph.D.

An Attempt to Use Provocation of the Radiosensitive Phases of Cell Life as an Adjunct to Fractional Radiation Therapy. T. Berkman and F. Dessauer. Strahlentherapie, 1937, **58,** 551.

It is known that heat shortens the time period of cell division. Since during mitosis cells are most susceptible to irradiation the author used diathermy in patients with inoperable malignancies before radiation therapy in an attempt to sensitize the tumor cells. The interval between heat application and irradiation was usually one hour. While only 12 cases have been studied so far and in some patients no benefit of the diathermy application could be seen, a few showed rather striking responses. The authors believe it to be worth while, therefore, to continue theses experiments.

ERNST A. POHLE, M.D., Ph.D.

Fractional and Protracted Fractional Radiation Therapy. H. R. Schinz. Strahlentherapie, 1937, **58,** 541.

The author uses at his clinic the following four types of application of roentgen rays: simple fractionation with short treatment periods, protracted fractional irradiation with short treatment periods, fractional irradiation with long treatment periods, and protracted fractional irradiation with long treatment periods. His daily doses vary from 14 to 40 r/min. for the short treatment periods and 2.5 r/min. for the long treatment periods. His results obtained by the original Coutard method in the treatment of carcinoma of the upper respiratory tract and esophagus are published in the same journal (Vol. **58,** p. 373). In conclusion, the author emphasizes that, in his opinion, an improvement of the results obtained by radiation therapy in cancer can be obtained only by earlier diagnosis.

ERNST A. POHLE, M.D., Ph.D.

Physical Experiments to Prove the Existence of Mitogenetic Radiation. L. Grebe, A. Krost, and L. Peukert. Strahlentherapie, 1937, **60,** 575.

The existence of mitogenetic radiation, discovered by Gurwitsch, is accepted by some and denied by other investigators. The authors studied the problem with a modified Geiger counter using the roots and leaves of plants and also frog hearts as test objects. They came to the conclusion that there are mitogenetic rays probably in the region of from 1,800 to 2,700 Å.

ERNST A. POHLE, M.D., Ph.D.

RADIATION INJURIES

Late Injuries Due to Roentgen Rays. C. Kruchen. Strahlentherapie, 1937, **60,** 466.

The author reports two cases of late injuries occurring years after the exposure to roentgen rays. The first patient, now 65 years old, was treated over the thyroid twenty years ago. Atrophy of the skin with telangiectasis developed several years after the irradiation. A few months ago the patient noticed difficulty in swallowing and clinical examination revealed a carcinoma of the hypopharynx which was proved by biopsy. What connection this malignancy has to the previous irradiation is difficult to say, although the changes in the skin may lead one to suspect certain injuries in the deeper structures. A second patient was operated on several times for sarcoma in the right groin. Fairly heavy doses of x-rays were applied for the treatment of a recurrence. Two years following the last treatment there developed an ulcer 12 × 9 cm. large and 4 to 5 cm. deep. In this case the disturbance of the blood supply and lymphatic drainage may explain the increased sensitivity to radiation.

ERNST A. POHLE, M.D., Ph.D.

A Brief Discussion of the Histological Changes in Irradiated Blood Vessels. F. Windholz. Strahlentherapie, 1937, **59,** 662.

The author reports the results of his studies carried out in serial sections of a roentgen ulcer in the abdominal wall of a patient who had received over that area a single dose of 1,500 r filtered through 4 mm. Al. Histologic studies showed that the veins were much more affected than the arteries. The findings are discussed in detail and illustrated by five photomicrograms. An additional illustration shows the identical microscopic picture in the perichondrium taken from the larynx of a patient who had been treated with the Coutard method and received 5,340 r within 35 days. He died from pneumonia 75 days after the last treatment. It is concluded that the observed changes in the veins are in all probability due to a direct effect of the radiation on the vessel walls.

ERNST A. POHLE, M.D., Ph.D.

Classification of Roentgen and Radium Injuries in Relation to Indications for Roentgen and Radium Therapy. H. Holfelder. Strahlentherapie, 1937, **60,** 66.

Following a brief discussion of the medico-legal aspect of roentgen and radium injuries, the author proposes a classification of these lesions, which, in his opinion, would greatly facilitate their evaluation in forensic medicine. The following groups are given: (1) pigmentation of skin; (2) telangiectasis; (3) atrophy

without changes in the subcutaneous tissue; (4) atrophy with changes in the subcutaneous tissue; (5) atrophy of mucous membranes; (6) ulceration of skin with tendency to heal; (7) ulceration of the skin without tendency to heal; (8) hyperkeratosis in atrophic skin; (9) development of cancer in atrophic skin.

ERNST A. POHLE, M.D., Ph.D.

Occurrence of a Sarcoma in the Scar of a Surgically Removed Roentgen Carcinoma. K. Gütig. Strahlentherapie, 1937, **59,** 687.

In 1932 the author reported a case of roentgen carcinoma which had developed on the dorsum of the hand. Following its surgical removal, the patient remained well for two years. At that time a newgrowth appeared in the scar, of red color and mushroom shape. Other carcinomas developed on the third and fourth fingers of the same hand. All tumors were removed. Histologic examination verified the diagnosis of roentgen carcinoma of the growth on the third and fourth fingers, but the recurrent growth in the scar was now a fibrosarcoma which showed cancroid pearls (three photomicrograms). No theory is offered explaining this change from a primary roentgen carcinoma to a sarcoma two years after operation. The patient has been well for two years.

ERNST A. POHLE, M.D., Ph.D.

RADIATION THERAPY

Experiments with the Rotation Method in Roentgen Therapy. F. Dessauer, K. Lion, and M. Gökmen. Strahlentherapie, 1937, **60,** 546.

This is a preliminary report concerning a new treatment method for deep-seated malignancies. It is based on the rotation of the patient's body during the exposure, with the diseased tissue placed in the rotation axis. It is possible to administer a much larger dose in the depth without injuring the skin. A few case reports are briefly quoted to demonstrate the advantages of the rotation method.

ERNST A. POHLE, M.D., Ph.D.

Twenty Years of Roentgen Therapy. M. Lüdin. Strahlentherapie, 1937, **60,** 483.

This is a very interesting review of 2,908 patients subjected to irradiation during 1916–1935 at the Roentgen Institute of the University of Basel. While it is not suitable for abstracting and should be studied in the original, the following data based on 1,665 selected cases are submitted to give an idea of the tremendous material discussed and critically evaluated. The report is based on 457 cases of tuberculous cervical adenitis, 113 cases of peritoneal tuberculosis and 197 of various types of tuberculosis; 29 cases of malignant struma, 112 cases of hyperthyroidism, 27 of hypophyseal tumors, 12 of tumors of the salivary glands, 5 cases of hypertrophy of the prostate, 117 of arthritis deformans, 18 of bursitis calcarea, 63 cases of carcinoma of the bronchus and of the lungs, 4 cases of actinomycosis of the lungs and pleura, 40 cases of bronchial asthma, 79 cases of diseases of the nervous system, 130 cases of erysipelas, 10 of thrombophlebitis, 11 of polycythemia, 4 of essential thrombopenia; 42 cases of chronic myeloid leukemia, 24 of chronic lymphatic leukemia, 9 of acute leukemia, 12 cases of aleukemic lymphadenosis, 3 of aleukemic myelosis, 2 cases of tuberculosis of the spleen; 61 cases of lymphogranulomatosis, 84 cases of sarcoma, including melano-, lympho-, round-cell, spindle-cell sarcoma and glioma. Roentgen injuries are also briefly discussed.

ERNST A. POHLE, M.D., Ph.D.

RADIOLOGY, PRACTICE OF

Roentgen Rays and Gross Structure of Matter. W. H. Bragg. Strahlentherapie, 1937, **58,** 193.

This is the German translation of the fifteenth Mackenzie-Davidson Lecture given by the author. The English translation will be found in the "British Journal of Radiology," 1935, **8,** 144.

ERNST A. POHLE, M.D., Ph.D.

RADIUM

Physical Foundations of Emanation Therapy. S. Meyer. Strahlentherapie, 1937, **58,** 656.

The author supplies data on the method of administering radium emanation, how long it remains in the body and how it is excreted. He considers inhalation, administration *per os* either in solution or in substance, bath, and radon ointments and oils.

ERNST A. POHLE, M.D., Ph.D.

Dosimetric Problems in Radium and Roentgen Therapy. H. Smereker. Strahlentherapie, 1937, **58,** 676.

The author describes the results of his measurements done with a carbon chamber on an apparatus for teleradium therapy containing 3 grams of radium. Data are also given for a smaller model containing 400 mg. of radium. The average dose for a carcinoma varied from 8,900 to 12,500 r. Thyrotoxicosis is given 1,300 r and epithelioma in the corner of the eye 7,800 r. A special cone for contact therapy is also described.

ERNST A. POHLE, M.D., Ph.D.

The Problem of Radium Dosimetry: The Photographic Method. W. Friedrich, U. Henschke, and R. Schulze. Strahlentherapie, 1937, **60,** 22.

The authors undertook a thorough study of the accuracy of the photographic method in radium dosimetry. They found that if carried out properly it is reliable and sufficiently accurate for practical purposes. Up to a certain point the degree of blackening is directly proportional to the dose. The quotient blackening/ionization depends on the filtration; if the dose is determined close to the radium screen through thin filters, it has to be considered. The method previously described by Holthusen and his co-workers was also

studied. (See "Strahlentherapie," 1932, **43,** 667.) The authors suggest the use of water as absorbing material instead of wood, and also refer the dose to 1 mg. of radium element. The equivalent for this "normal cube minute" was determined at 0.00412 r.

ERNST A. POHLE, M.D., Ph.D.

Radium Therapy of Cancer of the Oral Cavity. H. E. Davis. Illinois Med. Jour., October, 1937, **72,** 320–323.

Davis considers the use of low intensities of radium over a period of days to be effective in the treatment of carcinoma. Six to ten skin erythema doses were found to be most effective for the complete destruction of most squamous-cell carcinomas. With the exception of a few locations, such as the alveolar ridge, interstitial radiation was the method of choice for the treatment of oral cancer. Radium needles of low intensity, 0.5 to 1.0 mg. per linear cm., were ordinarily employed. They were screened with 0.5 mm. of platinum, thus allowing the use of only the pure gamma rays. The needles were spaced accurately about 10 to 12 mm. apart throughout the involved area. The period of application varied from 4 to 12 days continuously, depending upon the location, extent, and probable histology of the primary tumor. In certain locations radon implants were found practical, the dosage tables by Dr. Martin, Mrs. Quimby, and Dr. Pack being used.

G. E. BURCH, M.D.

Further Experience with Injections of Radium Chloride. W. Altschul. Strahlentherapie, 1937, **60,** 381.

The author reports on his experience with injection of radium chloride during the last five years. He saw good results in ischias, arthritis of the shoulder and knee, rheumatism, and neuritis. Certain types of arteriosclerotic disturbances as, for instance, intermittent claudication, were also improved. The injections are given in two series of six each; 3×1 mc. and 3×2 mc. on six successive days. There were no untoward reactions.

ERNST A. POHLE, M.D., Ph.D.

The Indications for the Use of Radio-active Thermal Waters in Great Britain. Sidney Russ. Proc. Royal Soc. Med., May, 1937, **30,** 831, 832.

In a discussion of spa waters, Professor Russ points out that the radium or radon in spa waters has often been put forward as a reason for some of the therapeutic value of the drinking water of the spa. He also points out that if this were so, spa waters richest in these elements would be among the most noted. This, however, is not the case. The drinking water of Stockholm is more radio-active than the water from any of Sweden's spas. Since radon water can be prepared cheaply, if the curative value of spa waters were due to this element, the value of such resorts would disappear rapidly.

In reply to the statement that small quantities of radium invigorate the body, Professor Russ has calculated that such water could safely supply only one-millionth of the heat requirements of the body. Similar calculation of the oxidation properties of clinically tolerated doses gives a very small figure.

Finally, the author points out the work of Howitt in administering radon-impregnated water. These results indicated that in the systematic treatment of cases of rheumatism and allied affections, no demonstrable change was found in the clinical condition, including a two-year follow-up.

The great benefit patients derive from spas is apparently not due to radio-activity but no doubt to the medical advice received, the régime of life followed, and the other chemical compounds contained in such waters.

W. A. SODEMAN, M.D.

Photographic Method for Testing Radium Applicators for Leakage. K. G. Zimmer and P. M. Wolf. Strahlentherapie, 1937, **58,** 174.

The regulations for radiation protection in Germany demand that all radium applicators be tested every three months for leakage. The authors describe their experiments, showing that the photographic method, if carried out with certain precautions, is suitable for this purpose.

ERNST A. POHLE, M.D., Ph.D.

Contributions to the Dosage Measurement on Radium Packs. E. Hasché, J. Bolze, L. v. Bozóky, and D. v. Keiser. Strahlentherapie, 1937, **60,** 598.

The authors describe in detail the results of their photographic determinations of radium doses with the photographic method developed by Holthusen and his co-workers (see this Journal 1932, **43,** 667). They found that gamma rays of radium and roentgen rays excited at 470 kv. (H.V.L.$_{Cu}$ 4.6 mm.) produce about the same degree of blackening of an x-ray film with a dose of 0.72 r. The accuracy is ± 20 per cent.

ERNST A. POHLE, M.D., Ph.D.

The Problem of Radium Dosimetry: Fundamental Principles of the Ionization Method. W. Friedrich, R. Schulze, and U. Henschke. Strahlentherapie, 1937, **60,** 38.

The authors continued their experimental investigations dealing with the determination of radium doses in r. They found that this is possible with air wall chambers. They found equal ionization currents if the electron emission of air under 150 atmospheres pressure was compared with that of graphite. Equal ionization currents were also obtained when comparing chambers made of tissue paper and air wall chambers, provided that the room was sufficiently large ($100 \times 50 \times 22$ meters) and the radium was at a distance of 20 meters from the chamber. The authors conclude that accurate results can be obtained only if air wall chambers of sufficient wall thickness are used and if scattered gamma radiation is avoided. The equivalent for 1 mg.-hr. was found to be 7.8 r.

ERNST A. POHLE, M.D., Ph.D.

Carcinoma Tongue—Radium Treatment and its Technic. S. B. Cooper. Jour. Indian Med. Assn., September, 1937, **6,** 665–670.

The tongue is attacked by squamous-cell carcinoma of which there are two varieties, one which produces cell nests and the other which does not. The tumor may be papillary, nodular, ulcerous, or fissured. Age incidence is from 41 to 72, and while no part of the tongue is exempt, most tumors occur on the anterior and lateral margins. Chronic infection and irritation, as from carious teeth, play an important part in the etiology. Diagnosis must be confirmed by microscopic examination and syphilitic lesions ruled out.

Treatment is directed to the primary lesion by the implantation of radium needles, and the glands in the neck are dealt with by block dissection. The local lesion is surrounded by needles each containing 1.33 mg. radium element, the filtration of each needle being 0.5 mm. platinum. Total dose averages 1,200 mg.-hr. Strict oral hygiene is maintained and four weeks after the radium treatment the block dissection of the neck is done. If affected glands are found, external irradiation of the neck is given several weeks later by means of x-ray or a radium collar using, roughly, 10,000 mg.-hr.

J. C. Rodick, M.D.

Contribution to the Treatment of Hemangioma by Means of Radio-active Substances. R. Muller. Strahlentherapie, 1937, **59,** 602.

The author reports 39 cases of hemangioma observed in his clinic since 1934. Ten of his patients were males and 29 females; most were between five months and three years old. The treatments were usually given over a one-year period; first with from six to eight weeks and then three months between sittings; 10 mg. radium screens, 1.4 cm. long, filtered through 2 mm. Ag; also 0.5 mm. Pt, with one milligram per square centimeter of skin surface, were used. Occasionally removable seeds were required; they contained 0.5 mc. per cm. length with a wall thickness of 0.1 mm. Au. They were inserted 1 cm. apart and left in the tissue up to 60 hours. A last method consisted of the application of radon screens filtered through 0.5 mm. brass; 0.4 mc. per sq. cm. was given per sitting. Re-examination of all treated patients did not reveal any radiation injuries. Thirty-five of the children were entirely cured, two considerably improved, and only two received no benefit from the treatment.

Ernst A. Pohle, M.D., Ph.D.

RICKETS

A New Zone of Destruction in the Shoulder Blade in Rachitis. Henry Kilian. München. med. Wchnschr., Aug. 27, 1937, **84,** 1362.

To the previously observed zones of destruction the author adds one found in the scapula, occurring in the thinned bone half-way between the inferior angle and the spine. The cause is the disproportion between the strength of the bone and the mechanical strain of the muscle pull. The lamellary bone, poorly built to withstand mechanical strain, is repaired by spotty ossification. This in the roentgenogram has the appearance of a solution of continuity, which in contrast to fracture is smooth. Clinically no findings are noted, and the classical signs of fracture are absent. When the rickets heals, a laying down of calcium in the zone of destruction occurs. The roentgenogram then shows dense calcium shadows, indicating that the calcium is deposited in the thickened osteoid bed.

L. G. Jacobs, M.D.

ROENTGENOLOGY, HISTORY OF

Medical Roentgenology around 1900. A. Köhler. Strahlentherapie, 1937, **60,** 283.

The author, who is well known to American radiologists, has written an interesting historical sketch describing the status of roentgenology about thirty-seven years ago. The technical facilities available then are briefly discussed as well as the first publications. Both diagnostic and therapeutic phases are considered and because the author speaks from his own experience the article has an attractive personal note.

Ernst A. Pohle, M.D., Ph.D.

ROENTGEN-RAY THERAPY

A Definition of the Technical Factors in Roentgen Therapy with Small Focal Skin Distances and its Differentiation from Other Similar Methods. H. Chaoul. Strahlentherapie, 1937, **59,** 533.

The author discusses his technic of roentgen therapy with relatively low potentials (60 kv., 2 mm. Cu), short F.S.D. (5 cm.) and high doses (10,000–15,000 r), because in some clinics the method has not been strictly adhered to, and therefore the results were not as good as with the original method.

Ernst A. Pohle, M.D., Ph.D.

ROENTGEN SICKNESS

The Systemic Effect of Roentgen Rays, with Special Consideration of a Shocking Effect Produced by Histamine or Histamine-like Substances. E. Forfota. Strahlentherapie, 1937, **59,** 643.

The author continued his studies reported in a previous paper regarding the relation between histamine and radiation sickness ("Strahlentherapie," 1937, **59,** 258). Prophylactic administration of histamine prevented radiation sickness in animals. He suggests, therefore, that this substance be given a trial in the treatment of human radiation sickness.

Ernst A. Pohle, M.D., Ph.D.

THE SINUSES

The Analysis of Increased Densities over the Nasal Sinuses Due to Projection. Theodor Bársony and Miklos Weiss. Röntgenpraxis, January, 1938, **10,** 5–8.

A slight deviation from the correct positioning of the head for the different postero-anterior positions used for the demonstration of the nasal sinuses may produce a definite but false density over the maxillary and ethmoid sinuses. Correct positioning may be judged accurately on the film by noting the position of the dental process of the second cervical vertebra. Any deviation of the dental process from the midline is always responsible for definite changes in the density of the antrum. The side toward which the dens is deviated is cloudy. Quite often the ethmoidal cells appear to be falsely cloudy at the side opposite the deviation of the dental process.

HANS W. HEFKE, M.D.

Roentgen Therapy of Chronic Sinusitis in Children. R. Rhett Rathbone. Am. Jour. Roentgenol. and Rad. Ther., July, 1937, **38,** 102–108.

In 70 children with sinus disease followed from one to three and one-half years by roentgen examinations before and after roentgen treatment, 57 per cent were cured, 28 per cent improved, and 15 per cent were not benefited.

The ideal type for roentgen therapy is the one with diffuse lymphoid hyperplasia throughout the nose and throat, hyperplasia of the mucous membrane of the antra, ethmoids, and adenoids, the last of which can be shown in the lateral view, which always should be taken in children. The roentgen prescription employed was either 125 kv. (peak) 5 ma., 12-inch distance, 5 mm. Al filter, and a dose of 120 r, or, 220 kv. (peak) 20 ma., 50 cm. distance, 0.5 mm. copper filter, and a dose of 100 r (measured in air). The treatments were given three times per week for two weeks through portals of 10 × 10 cm. or 7 × 7 cm., through anterior and right and left fields in rotation, and only one field per day. In seven cases with recurrent sinus disease the series was repeated in six months to one year with excellent results in four.

The diagnosis of this disease is not easy and is frequently marked by cough, lung congestion, bronchiectasis, asthma, otitis media, mastoiditis, and cervical adenopathy, which may be either associated with this disease, or the result of it.

S. M. ATKINS, M.D.

Marconi-therapy in Chronic Sinusitis. F. Talia. Arch. di Radiol., 1937, **8,** 23–31.

Talia reports favorable results in a group of cases of sinusitis after the use of short wave therapy.

E. T. LEDDY, M.D.

SKIN DISEASES

Treatment of Skin Cancer. Everett C. Fox. Southwestern Med., October, 1937, **21,** 354–357.

The author lists the precancerous dermatoses and the different types of skin malignancy, outlining the treatment which he considers offers the best prognosis.

JOHN M. MILES, M.D.

The Method of "Three Fractional Doses" in Roentgen Therapy of Skin Diseases. A. Stühmer. Strahlentherapie, 1937, **60,** 706.

The author discusses the method of application in dermatological roentgen therapy. For many years it has been the custom to apply about 20 per cent of the skin erythema dose every ten days. Based on the investigations of Miescher, who found a definite rhythm in the skin reaction following exposure to roentgen rays, the author suggests trying the following method: 30 per cent of the erythema dose is given first, 20 per cent after ten days, 10 per cent ten days later. If more treatment is required, 10 per cent may be given on the fortieth and on the fiftieth day. The chosen periods correspond to the three erythema cycles described by Miescher.

ERNEST A. POHLE, M.D., Ph.D.

Lupus Sarcoma. A. Beller. Strahlentherapie, 1937, **60,** 210.

The author reports a case of a man 72 years of age who had been treated for lupus of the skin. In one of the scars a nodule developed and grew within eight weeks to 2 cm. diameter. Excision by the endotherm knife was done; biopsy showed a polymorph cell sarcoma. The wound healed within six weeks; at that time a recurrence of bean-size developed. Roentgen therapy was given to that area (185 kv., 0.5 mm. Cu, 60 per cent H.E.D.). The growth responded promptly and the patient has been free from recurrence for one year and three months.

ERNST A. POHLE, M.D., Ph.D.

The Problem of Atypical Skin Reactions Following Roentgen Irradiation. A. Kautzky. Strahlentherapie, 1937, **60,** 439.

It is known that exposure to roentgen rays may provoke skin eruptions in patients with hyperthyroidism, psoriasis, and syphilis. The author has observed a number of cases belonging to this group and describes, for instance, the appearance of an acne rosacea in some of the irradiated areas in a woman who received roentgen deep therapy over the pelvis for carcinoma of the cervix. Another patient, treated for hyperthyroidism, developed urticaria not only in the treated fields but in various other parts of the body. A patient with hemolytic icterus developed a marked erythema in the skin

areas over the spleen, which had received only 50 r. Pigmentation was still visible three months after the treatment. Another patient, who received 4,000 r in fractional doses over the thyroid (carcinoma), suffered from infection of the entire area after she had scratched a small region in the margin.

The author considers the question as to whether or not these reactions are merely local or of a systemic nature and consequently affect the entire blood vessel system. In his opinion reactions of the type described remind one more of the sensitizations which are, for instance, seen after administration of barbituric acid and its derivatives.

ERNST A. POHLE, M.D., Ph.D.

THE SKULL

The Healing of Linear Fractures of the Skull. Robert G. Vance. Am. Jour. Roentgenol. and Rad. Ther., December, 1936, **36,** 744–746.

Fifty-two patients with linear skull fractures involving some portion of the vault or base were re-examined over a period of several years in order to determine the time limits for healing with disappearance of the x-ray evidence of fracture. The earliest time for complete healing was four months and twenty days in an occipital bone fracture in a boy four years of age. After about eight months the fracture in adults takes on the appearance of an old one, and healing is usually completed, with loss of all evidence of the fracture in about two years. The wider the fracture line, the longer will be the time required for healing.

J. E. HABBE, M.D.

THE SPINE

Radiography of the Coccyx. Carlo Guarini. Archivio di Radiologia, 1937, **15,** 228–235.

After briefly mentioning the orthopedic and medico-legal importance that fractures of the coccyx may have, Guarini describes and illustrates an intra-rectal method of radiography of the coccyx.

E. T. LEDDY, M.D.

THE SPLEEN

Traumatic Hematoma Encysted in the Splenic Region. P. Goinard, C. Viallet, and R. Marchioni. Bull. et Mém. Soc. Radiol. Méd. de France, February, 1937, **25,** 156–158.

The authors present three cases demonstrating the value of the roentgenograph in diagnosis of traumatic hematoma in the splenic region and spleen.

S. RICHARD BEATTY, M.D

THE STOMACH

The Expectancy of Life in Patients with Carcinoma of the Stomach. A. Kahlstorf. Strahlentherapie, 1937, **60,** 100.

The author analyzes 336 patients with carcinoma of the stomach observed in the medical clinic of the University of Wurzburg; 55 per cent of these were inoperable on first examination. A resection could be done in only 23 patients. Two of these lived through a five-year period without symptoms and a third patient has been free from symptoms for three and one-half years. The roentgenologic diagnosis is discussed and several illustrative roentgenograms are appended. In the author's opinion early diagnosis and early operation offer these patients the best and only chance for a cure.

ERNST A. POHLE, M.D., Ph.D.

SYPHILIS

Pulmonary Syphilis. Pietro Gerli. Archivio di Radiologia, September–December, 1936, **15,** 279–328.

After a review of the literature on pulmonary syphilis Gerli presents three personal cases, one of which had autopsy control, two therapeutic, and a fourth from the service of Prof. Bignami. By reproductions of roentgenograms the author illustrates the various forms this lesion may take—either that of a tumor or that of a diffuse infiltration. The differential diagnosis is difficult and may be possible only after a therapeutic test. The article has an extensive bibliography.

E. T. LEDDY, M.D.

THE TRACHEA

The Normal Trachea in Anteroposterior Roentgenograms. Theodor Bársony and Béla Wald. Röntgenpraxis, March, 1937, **9,** 164–180.

An anteroposterior roentgenogram of the trachea, taken best with the Bucky diaphragm, gives a great deal of detail of the normal structure of the trachea. The anatomical picture of the trachea is sometimes difficult to determine because shadows of organs lying anterior and posterior to it are superimposed. The roentgen appearance of the normal trachea is described in detail and the relationship between the trachea and the surrounding organs, as shown on roentgenograms, is pointed out systematically.

HANS W. HEFKE, M.D.

TUMORS (THERAPY)

The Effects of Irradiation on Gliomas. C. H. Frazier, Bernard J. Alpers, E. P. Pendergrass, and George W. Chamberlin. Am. Jour. Roentgenol. and Rad. Ther., July, 1937, **38,** 203–238.

Thirty gliomas were studied exhaustively before and after irradiation in order to determine the histologic effects of irradiation for guidance in future treatment. Medulloblastomas and ependymomas are radiosensitive, glioblastoma multiforme and astrocytomas only mildly so, and oligodendrogliomas showed no response. The changes, where present, were primarily in the cells, next in the connective tissue stroma, and least in the vessels.

Although radiation therapy is at present not completely satisfactory, nevertheless, with more adequate therapy such as the Coutard protracted method with

numerous portals and up to the limit of skin tolerance per field, better results can be anticipated.

S. M. ATKINS, M.D.

Coutard Treatment of Malignant Tumors. S. A. Heyerdahl. Acta Radiologica, May, 1937, **18**, 399–412.

The author relates experiences with the Coutard treatment during 1932 and 1933 with follow-up for from two and one-half to four years. Sixteen out of 25 cases of carcinoma of the throat and other air passages were symptom-free. Of nine patients with bone tumors, all were free of pain after Coutard treatment, and four of them symptom-free after from two and one-half to four years. The author states that if attention is concentrated not solely on the permanent results, but also on the immediate effects of the treatment, the method must be said to be very promising and of importance to the patient. The mode of treatment and complications observed are also given.

W. A. SODEMAN, M.D.

Radiotherapeutic Experiences in the Treatment of Malignant Tumors of the Upper Air and Digestive Passages Complicated by Regional Lymph Gland Metastases. A. Pagani. Strahlentherapie, 1937, **60**, 675.

In this third part of his report, the author discusses tumors of the epipharynx, hypopharynx, and larynx. Twenty-six patients with tumors of the epipharynx with metastatic glands showed a three-year survival of 25 per cent and a five-year survival of 20 per cent. Protracted fractional roentgen therapy is the method of choice. Small local residual tumors are removed with the endotherm knife or are treated by radium implantation. Any residual lymph glands are removed surgically, provided, of course, that the primary lesion has been completely eradicated. Treated by the same method were 151 patients with tumors of the hypopharynx with metastatic glands. After three years 13 per cent survived and after five years 7 per cent. Thirty-four cases with carcinoma of the larynx were seen; only six of these had metastatic glands. One of the cases with metastases in the glands was alive at the end of five years. The author emphasizes again the relationship between prognosis and metastases in the regional glands.

ERNST A. POHLE, M.D., Ph.D.

THE WRIST

The Roentgenological Diagnosis of Fractures of the Navicular Bone. A. Perschl. Röntgenpraxis, January, 1938, **10**, 11–16.

Fractures of the navicular bone of the wrist are not uncommon. The statistical material of the Clinic of Boehler, in Vienna, shows that there is found one recent fracture of the navicular bone to five of the wrist itself. Its definite diagnosis is often impossible by clinical examination and assured only by x-ray examination. If not diagnosed and not immobilized for at least six weeks, a long-lasting disability and pseudoarthrosis may follow. The standard positions for roentgen examination of the wrist are the lateral and dorso-palmar views. The author shows that these two exposures are not sufficient in many cases of fractures of the navicular bone. Four positions are at present used routinely in Boehler's Clinic: the two standard views and two special positions for better visualization of the small bones of the wrist, especially the naviculare. For one of them the direction of the central ray is dorsopalmar, but the fingers are flexed to almost make a fist; for the second position the fingers are flexed and the hand is supinated to an angle of 45 degrees.

By means of several case reports and reproductions of films the author proves his contention that in some cases fractures of the navicular bone cannot be diagnosed without the two special views. Of 302 recent fractures of that bone seen during the last eleven years at Boehler's Clinic, all healed with bony union when diagnosed correctly and treated by immobilization for a sufficient time—at least six weeks.

HANS W. HEFKE, M.D.